

MSC2020-Mathematical Sciences Classification System

Associate Editors of Mathematical Reviews and zbMATH

- 00** General and overarching topics; collections
- 01** History and biography
- 03** Mathematical logic and foundations
- 05** Combinatorics
- 06** Order, lattices, ordered algebraic structures
- 08** General algebraic systems
- 11** Number theory
- 12** Field theory and polynomials
- 13** Commutative algebra
- 14** Algebraic geometry
- 15** Linear and multilinear algebra; matrix theory
- 16** Associative rings and algebras
- 17** Nonassociative rings and algebras
- 18** Category theory; homological algebra
- 19** K -theory
- 20** Group theory and generalizations
- 22** Topological groups, Lie groups
- 26** Real functions
- 28** Measure and integration
- 30** Functions of a complex variable
- 31** Potential theory
- 32** Several complex variables and analytic spaces
- 33** Special functions
- 34** Ordinary differential equations
- 35** Partial differential equations
- 37** Dynamical systems and ergodic theory
- 39** Difference and functional equations
- 40** Sequences, series, summability
- 41** Approximations and expansions
- 42** Harmonic analysis on Euclidean spaces
- 43** Abstract harmonic analysis
- 44** Integral transforms, operational calculus
- 45** Integral equations
- 46** Functional analysis
- 47** Operator theory
- 49** Calculus of variations and optimal control; optimization
- 51** Geometry
- 52** Convex and discrete geometry
- 53** Differential geometry
- 54** General topology
- 55** Algebraic topology
- 57** Manifolds and cell complexes
- 58** Global analysis, analysis on manifolds
- 60** Probability theory and stochastic processes
- 62** Statistics
- 65** Numerical analysis
- 68** Computer science
- 70** Mechanics of particles and systems
- 74** Mechanics of deformable solids
- 76** Fluid mechanics
- 78** Optics, electromagnetic theory
- 80** Classical thermodynamics, heat transfer
- 81** Quantum theory
- 82** Statistical mechanics, structure of matter
- 83** Relativity and gravitational theory
- 85** Astronomy and astrophysics
- 86** Geophysics
- 90** Operations research, mathematical programming
- 91** Game theory, economics, social and behavioral sciences
- 92** Biology and other natural sciences
- 93** Systems theory; control
- 94** Information and communication, circuits
- 97** Mathematics education

This document is a printed form of MSC2020, an MSC revision produced jointly by the editorial staffs of Mathematical Reviews (MR) and Zentralblatt für Mathematik (zbMATH) in consultation with the mathematical community. The goals of this revision of the Mathematics Subject Classification (MSC) were set out in the announcement of it and call for comments by the Executive Editor of MR and the Chief Editor of zbMATH in July 2016. This document results from the MSC revision process that has been going on since then. MSC2020 will be fully deployed from January 2020.

The editors of MR and zbMATH deploying this revision therefore ask for feedback on remaining errors to help in this work, which should be given through e-mail to feedback@msc2020.org. They are grateful for the many suggestions that were received previously, which have greatly influenced what we have.

How to use the Mathematics Subject Classification [MSC]

The main purpose of the classification of items in the mathematical literature using the Mathematics Subject Classification scheme is to help users find the items of present or potential interest to them as readily as possible—in products derived from the Mathematical Reviews Database (MRDB) such as MathSciNet, in Zentralblatt MATH (zbMATH), or anywhere else where this classification scheme is used. An item in the mathematical literature should be classified so as to attract the attention of all those possibly interested in it. The item may be something that falls squarely within one clear area of the MSC, or it may involve several areas. Ideally, the MSC codes attached to an item should represent the subjects to which the item contains a contribution. The classification should serve both those closely concerned with specific subject areas, and those familiar enough with subjects to apply their results and methods elsewhere, inside or outside of mathematics. It will be extremely useful for both users and classifiers to familiarize themselves with the entire classification system and thus to become aware of all the classifications of possible interest to them. Every item in the MRDB or zbMATH receives precisely one primary classification, which is simply the MSC code that describes its principal contribution. When an item contains several principal contributions to different areas, the primary classification should cover the most important among them. A paper or book may be assigned one or several secondary classification numbers to cover any remaining principal contributions, ancillary results, motivation or origin of the matters discussed, intended or potential field of application, or other significant aspects worthy of notice. The principal contribution is meant to be the one including the most important part of the work actually done in the item. For example, a paper whose main overall content is the solution of a problem in graph theory, which arose in computer science and whose solution is (perhaps) at present only of interest to computer scientists, would have a primary classification in 05C (Graph Theory) with one or more secondary classifications in 68 (Computer Science); conversely, a paper whose overall content lies mainly in computer science should receive a primary classification in 68, even if it makes heavy use of graph theory and proves several new graph-theoretic results along the way. There are two types of cross-references given at the end of many of the MSC2020 entries in the MSC. The first type is in braces: “{For A, see X}”; if this appears in section Y, it means that contributions described by A should usually be assigned the classification code X, not Y. The other type of cross-reference merely points out related classifications; it is in brackets: “[See also ...]”, “[See mainly ...]”, etc., and the classification codes listed in the brackets may, but need not, be included in the classification codes of a paper, or they may be used in place of the classification where the cross-reference is given. The classifier must judge which classification is the most appropriate for the paper at hand.

00-XX General and overarching topics; collections

00-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to mathematics in general

00-02 Research exposition (monographs, survey articles) pertaining to mathematics in general

00Axx General and miscellaneous specific topics

00A05 Mathematics in general

00A06 Mathematics for nonmathematicians (engineering, social sciences, etc.)

00A07 Problem books {For open problems, see [00A27](#)}

00A08 Recreational mathematics

00A09 Popularization of mathematics

00A15 Bibliographies for mathematics in general [See also [01A70](#) and the classification number -00 in the other sections]

00A17 External book reviews

00A20 Dictionaries and other general reference works [See also the classification number -00 in the other sections]

00A22 Formularies

00A27 Lists of open problems

00A30 Philosophy of mathematics [See also [03A05](#)]

00A35 Methodology of mathematics {For mathematics education, see [97-XX](#)}

00A64 Mathematics and literature

00A65 Mathematics and music

00A66 Mathematics and visual arts

00A67 Mathematics and architecture

00A69 General applied mathematics {For physics, see [00A79](#) and Sections [70](#) through [86](#)}

00A71 General theory of mathematical modeling

00A72 General theory of simulation

00A79 Physics (Use more specific entries from Sections [70](#) through [86](#) when possible)

00A99 None of the above, but in this section

00Bxx Conference proceedings and collections of articles

00B05 Collections of abstracts of lectures

00B10 Collections of articles of general interest

00B15 Collections of articles of miscellaneous specific interest

00B20 Proceedings of conferences of general interest

00B25 Proceedings of conferences of miscellaneous specific interest

00B30 Festschriften

- 00B50** Collections of translated articles of general interest
- 00B55** Collections of translated articles of miscellaneous specific interest
- 00B60** Collections of reprinted articles [See also [01A75](#)]
- 00B99** None of the above, but in this section

01-XX History and biography [See also the classification number –03 in the other sections]

- 01-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to history and biography
- 01-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to history and biography
- 01-02** Research exposition (monographs, survey articles) pertaining to history and biography
- 01-06** Proceedings, conferences, collections, etc. pertaining to history and biography
- 01-11** Research data for problems pertaining to history and biography

01Axx History of mathematics and mathematicians

- 01A05** General histories, source books
- 01A07** Ethnomathematics, general
- 01A10** History of mathematics in Paleolithic and Neolithic times
- 01A11** History of mathematics of the indigenous cultures of Africa, Asia, and Oceania
- 01A12** History of mathematics of the indigenous cultures of the Americas
- 01A15** History of mathematics of the indigenous cultures of Europe (pre-Greek, etc.)
- 01A16** History of mathematics in Ancient Egypt
- 01A17** History of mathematics in Ancient Babylon
- 01A20** History of mathematics in Ancient Greece and Rome
- 01A25** History of mathematics in China
- 01A27** History of mathematics in Japan
- 01A29** History of mathematics in Southeast Asia
- 01A30** History of mathematics in the Golden Age of Islam
- 01A32** History of mathematics in India
- 01A35** History of mathematics in late antiquity and medieval Europe
- 01A40** History of mathematics in the 15th and 16th centuries, Renaissance
- 01A45** History of mathematics in the 17th century
- 01A50** History of mathematics in the 18th century
- 01A55** History of mathematics in the 19th century
- 01A60** History of mathematics in the 20th century

- 01A61** History of mathematics in the 21st century
- 01A65** Development of contemporary mathematics
- 01A67** Future perspectives in mathematics
- 01A70** Biographies, obituaries, personalia, bibliographies
- 01A72** Schools of mathematics
- 01A73** History of mathematics at specific universities
- 01A74** History of mathematics at institutions and academies (non-university)
- 01A75** Collected or selected works; reprintings or translations of classics [See also [00B60](#)]
- 01A80** Sociology (and profession) of mathematics
- 01A85** Historiography
- 01A90** Bibliographic studies
- 01A99** None of the above, but in this section

03-XX Mathematical logic and foundations

- 03-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to mathematical logic and foundations
- 03-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to mathematical logic and foundations
- 03-02** Research exposition (monographs, survey articles) pertaining to mathematical logic and foundations
- 03-03** History of mathematical logic and foundations [Consider also classification numbers pertaining to Section [01](#)]
- 03-04** Software, source code, etc. for problems pertaining to mathematical logic and foundations
- 03-06** Proceedings, conferences, collections, etc. pertaining to mathematical logic and foundations
- 03-08** Computational methods for problems pertaining to mathematical logic and foundations
- 03-11** Research data for problems pertaining to mathematical logic and foundations

03Axx Philosophical aspects of logic and foundations

- 03A05** Philosophical and critical aspects of logic and foundations {For philosophy of mathematics, see also [00A30](#)}
- 03A10** Logic in the philosophy of science
- 03A99** None of the above, but in this section

03Bxx General logic

03B05 Classical propositional logic

03B10 Classical first-order logic

03B16 Higher-order logic

03B20 Subsystems of classical logic (including intuitionistic logic)

03B22 Abstract deductive systems

03B25 Decidability of theories and sets of sentences [See also [11U05](#), [12L05](#), [20F10](#)]

03B30 Foundations of classical theories (including reverse mathematics) [See also [03F35](#)]

03B35 Mechanization of proofs and logical operations [See also [68V15](#)]

03B38 Type theory

03B40 Combinatory logic and lambda calculus [See also [68N18](#)]

03B42 Logics of knowledge and belief (including belief change)

03B44 Temporal logic

03B45 Modal logic (including the logic of norms) {For knowledge and belief, see [03B42](#); for temporal logic, see [03B44](#); for provability logic, see also [03F45](#)}

03B47 Substructural logics (including relevance, entailment, linear logic, Lambek calculus, BCK and BCI logics) {For proof-theoretic aspects see [03F52](#)}

03B48 Probability and inductive logic [See also [60A05](#)]

03B50 Many-valued logic

03B52 Fuzzy logic; logic of vagueness [See also [68T27](#), [68T37](#), [94D05](#)]

03B53 Paraconsistent logics

03B55 Intermediate logics

03B60 Other nonclassical logic

03B62 Combined logics

03B65 Logic of natural languages [See also [68T50](#), [91F20](#)]

03B70 Logic in computer science [See also [68-XX](#)]

03B80 Other applications of logic

03B99 None of the above, but in this section

03Cxx Model theory

03C05 Equational classes, universal algebra in model theory [See also [08Axx](#), [08Bxx](#), [18C05](#)]

03C07 Basic properties of first-order languages and structures

03C10 Quantifier elimination, model completeness and related topics

03C13 Model theory of finite structures [See also [68Q15](#), [68Q19](#)]

03C15 Model theory of denumerable and separable structures

03C20 Ultraproducts and related constructions

03C25 Model-theoretic forcing

03C30 Other model constructions

03C35 Categoricity and completeness of theories

03C40 Interpolation, preservation, definability

03C45 Classification theory, stability and related concepts in model theory [See also [03C48](#)]

03C48 Abstract elementary classes and related topics [See also [03C45](#)]

03C50 Models with special properties (saturated, rigid, etc.)

03C52 Properties of classes of models

03C55 Set-theoretic model theory

03C57 Computable structure theory, computable model theory [See also [03D45](#)]

03C60 Model-theoretic algebra [See also [08C10](#), [12Lxx](#), [13L05](#)]

03C62 Models of arithmetic and set theory [See also [03Hxx](#)]

03C64 Model theory of ordered structures; o-minimality

03C65 Models of other mathematical theories

03C66 Continuous model theory, model theory of metric structures

03C68 Other classical first-order model theory

03C70 Logic on admissible sets

03C75 Other infinitary logic

03C80 Logic with extra quantifiers and operators [See also [03B42](#), [03B44](#), [03B45](#), [03B48](#)]

03C85 Second- and higher-order model theory

03C90 Nonclassical models (Boolean-valued, sheaf, etc.)

03C95 Abstract model theory

03C98 Applications of model theory [See also [03C60](#)]

03C99 None of the above, but in this section

03Dxx Computability and recursion theory

03D03 Thue and Post systems, etc.

03D05 Automata and formal grammars in connection with logical questions [See also [68Q45](#), [68Q70](#), [68R15](#)]

03D10 Turing machines and related notions [See also [68Q04](#)]

03D15 Complexity of computation (including implicit computational complexity) [See also [68Q15](#), [68Q17](#)]

03D20 Recursive functions and relations, subrecursive hierarchies

03D25 Recursively (computably) enumerable sets and degrees

03D28 Other Turing degree structures

03D30 Other degrees and reducibilities in computability and recursion theory

03D32 Algorithmic randomness and dimension [See also [68Q30](#)]

03D35 Undecidability and degrees of sets of sentences

03D40 Word problems, etc. in computability and recursion theory [See also [06B25](#), [08A50](#), [20F10](#), [68R15](#)]

03D45 Theory of numerations, effectively presented structures [See also [03C57](#)] {For intuitionistic and similar approaches, see [03F55](#)}

03D50 Recursive equivalence types of sets and structures, isols

03D55 Hierarchies of computability and definability

03D60 Computability and recursion theory on ordinals, admissible sets, etc.

03D65 Higher-type and set recursion theory

03D70 Inductive definability

03D75 Abstract and axiomatic computability and recursion theory

03D78 Computation over the reals, computable analysis {For constructive aspects, see [03F60](#)}

03D80 Applications of computability and recursion theory

03D99 None of the above, but in this section

03Exx Set theory

03E02 Partition relations

03E04 Ordered sets and their cofinalities; pcf theory

03E05 Other combinatorial set theory

03E10 Ordinal and cardinal numbers

03E15 Descriptive set theory [See also [28A05](#), [54H05](#)]

03E17 Cardinal characteristics of the continuum

03E20 Other classical set theory (including functions, relations, and set algebra)

03E25 Axiom of choice and related propositions

03E30 Axiomatics of classical set theory and its fragments

- 03E35** Consistency and independence results
- 03E40** Other aspects of forcing and Boolean-valued models
- 03E45** Inner models, including constructibility, ordinal definability, and core models
- 03E47** Other notions of set-theoretic definability
- 03E50** Continuum hypothesis and Martin's axiom [See also [03E57](#)]
- 03E55** Large cardinals
- 03E57** Generic absoluteness and forcing axioms [See also [03E50](#)]
- 03E60** Determinacy principles
- 03E65** Other set-theoretic hypotheses and axioms
- 03E70** Nonclassical and second-order set theories
- 03E72** Theory of fuzzy sets, etc.
- 03E75** Applications of set theory
- 03E99** None of the above, but in this section

03Fxx Proof theory and constructive mathematics

- 03F03** Proof theory, general (including proof-theoretic semantics)
- 03F05** Cut-elimination and normal-form theorems
- 03F07** Structure of proofs
- 03F10** Functionals in proof theory
- 03F15** Recursive ordinals and ordinal notations
- 03F20** Complexity of proofs
- 03F25** Relative consistency and interpretations
- 03F30** First-order arithmetic and fragments
- 03F35** Second- and higher-order arithmetic and fragments [See also [03B30](#)]
- 03F40** Gödel numberings and issues of incompleteness
- 03F45** Provability logics and related algebras (e.g., diagonalizable algebras) [See also [03B45](#), [03G25](#), [06E25](#)]
- 03F50** Metamathematics of constructive systems
- 03F52** Proof-theoretic aspects of linear logic and other substructural logics [See also [03B47](#)]
- 03F55** Intuitionistic mathematics
- 03F60** Constructive and recursive analysis [See also [03B30](#), [03D45](#), [03D78](#), [26E40](#), [46S30](#), [47S30](#)]
- 03F65** Other constructive mathematics [See also [03D45](#)]
- 03F99** None of the above, but in this section

03Gxx Algebraic logic

- 03G05** Logical aspects of Boolean algebras [See also [06Exx](#)]
- 03G10** Logical aspects of lattices and related structures [See also [06Bxx](#)]
- 03G12** Quantum logic [See also [06C15](#), [81P10](#)]
- 03G15** Cylindric and polyadic algebras; relation algebras
- 03G20** Logical aspects of Lukasiewicz and Post algebras [See also [06D25](#), [06D30](#)]
- 03G25** Other algebras related to logic [See also [03F45](#), [06D20](#), [06E25](#), [06F35](#)]
- 03G27** Abstract algebraic logic
- 03G30** Categorical logic, topoi [See also [18B25](#), [18C05](#), [18C10](#)]
- 03G99** None of the above, but in this section

03Hxx Nonstandard models [See also [03C62](#)]

- 03H05** Nonstandard models in mathematics [See also [26E35](#), [28E05](#), [30G06](#), [46S20](#), [47S20](#), [54J05](#)]
- 03H10** Other applications of nonstandard models (economics, physics, etc.)
- 03H15** Nonstandard models of arithmetic [See also [11U10](#), [12L15](#), [13L05](#)]
- 03H99** None of the above, but in this section

05-XX Combinatorics {For finite fields, see [11Txx](#)}

- 05-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to combinatorics
- 05-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to combinatorics
- 05-02** Research exposition (monographs, survey articles) pertaining to combinatorics
- 05-03** History of combinatorics [Consider also classification numbers pertaining to Section [01](#)]
- 05-04** Software, source code, etc. for problems pertaining to combinatorics
- 05-06** Proceedings, conferences, collections, etc. pertaining to combinatorics
- 05-08** Computational methods for problems pertaining to combinatorics
- 05-11** Research data for problems pertaining to combinatorics

05Axx Enumerative combinatorics {For enumeration in graph theory, see [05C30](#)}

- 05A05** Permutations, words, matrices
- 05A10** Factorials, binomial coefficients, combinatorial functions [See also [11B65](#), [33Cxx](#)]
- 05A15** Exact enumeration problems, generating functions [See also [33Cxx](#), [33Dxx](#)]
- 05A16** Asymptotic enumeration
- 05A17** Combinatorial aspects of partitions of integers [See also [11P81](#), [11P82](#), [11P83](#)]
- 05A18** Partitions of sets
- 05A19** Combinatorial identities, bijective combinatorics

05A20 Combinatorial inequalities

05A30 q -calculus and related topics [See also [33Dxx](#)]

05A40 Umbral calculus

05A99 None of the above, but in this section

05Bxx Designs and configurations {For applications of design theory, see [94C30](#)}

05B05 Combinatorial aspects of block designs [See also [51E05](#), [62K10](#)]

05B07 Triple systems

05B10 Combinatorial aspects of difference sets (number-theoretic, group-theoretic, etc.) [See also [11B13](#)]

05B15 Orthogonal arrays, Latin squares, Room squares

05B20 Combinatorial aspects of matrices (incidence, Hadamard, etc.)

05B25 Combinatorial aspects of finite geometries [See also [51D20](#), [51Exx](#)]

05B30 Other designs, configurations [See also [51E30](#)]

05B35 Combinatorial aspects of matroids and geometric lattices [See also [52B40](#), [90C27](#)]

05B40 Combinatorial aspects of packing and covering [See also [11H31](#), [52C15](#), [52C17](#)]

05B45 Combinatorial aspects of tessellation and tiling problems [See also [52C20](#), [52C22](#)]

05B50 Polyominoes

05B99 None of the above, but in this section

05Cxx Graph theory {For applications of graphs, see [68R10](#), [81Q30](#), [81T15](#), [82B20](#), [82C20](#), [90C35](#), [92E10](#), [94C15](#)}

05C05 Trees

05C07 Vertex degrees [See also [05E30](#)]

05C09 Graphical indices (Wiener index, Zagreb index, Randić index, etc.)

05C10 Planar graphs; geometric and topological aspects of graph theory [See also [57K10](#), [57M15](#)]

05C12 Distance in graphs

05C15 Coloring of graphs and hypergraphs

05C17 Perfect graphs

05C20 Directed graphs (digraphs), tournaments

05C21 Flows in graphs

05C22 Signed and weighted graphs

05C25 Graphs and abstract algebra (groups, rings, fields, etc.) [See also [20F65](#)]

05C30 Enumeration in graph theory

05C31 Graph polynomials

05C35 Extremal problems in graph theory [See also [90C35](#)]

- 05C38 Paths and cycles [See also [90B10](#)]
- 05C40 Connectivity
- 05C42 Density (toughness, etc.)
- 05C45 Eulerian and Hamiltonian graphs
- 05C48 Expander graphs
- 05C50 Graphs and linear algebra (matrices, eigenvalues, etc.)
- 05C51 Graph designs and isomorphic decomposition [See also [05B30](#)]
- 05C55 Generalized Ramsey theory [See also [05D10](#)]
- 05C57 Games on graphs (graph-theoretic aspects) [See also [91A43](#), [91A46](#)]
- 05C60 Isomorphism problems in graph theory (reconstruction conjecture, etc.) and homomorphisms (subgraph embedding, etc.)
- 05C62 Graph representations (geometric and intersection representations, etc.) {For graph drawing, see also [68R10](#)}
- 05C63 Infinite graphs
- 05C65 Hypergraphs
- 05C69 Vertex subsets with special properties (dominating sets, independent sets, cliques, etc.)
- 05C70 Edge subsets with special properties (factorization, matching, partitioning, covering and packing, etc.)
- 05C72 Fractional graph theory, fuzzy graph theory
- 05C75 Structural characterization of families of graphs
- 05C76 Graph operations (line graphs, products, etc.)
- 05C78 Graph labelling (graceful graphs, bandwidth, etc.)
- 05C80 Random graphs (graph-theoretic aspects) [See also [60B20](#)]
- 05C81 Random walks on graphs
- 05C82 Small world graphs, complex networks (graph-theoretic aspects) [See also [90Bxx](#), [91D30](#)]
- 05C83 Graph minors
- 05C85 Graph algorithms (graph-theoretic aspects) [See also [68R10](#), [68W05](#)]
- 05C90 Applications of graph theory [See also [68R10](#), [81Q30](#), [81T15](#), [82B20](#), [82C20](#), [90C35](#), [92E10](#), [94C15](#)]
- 05C92 Chemical graph theory [See also [92E10](#)]
- 05C99 None of the above, but in this section

05Dxx Extremal combinatorics

- 05D05 Extremal set theory
- 05D10 Ramsey theory [See also [05C55](#)]
- 05D15 Transversal (matching) theory
- 05D40 Probabilistic methods in extremal combinatorics, including polynomial methods (combinatorial Nullstellensatz, etc.)
- 05D99 None of the above, but in this section

05Exx Algebraic combinatorics

05E05 Symmetric functions and generalizations

05E10 Combinatorial aspects of representation theory [See also [20C30](#)]

05E14 Combinatorial aspects of algebraic geometry [See also [14Nxx](#)]

05E16 Combinatorial aspects of groups and algebras [See also [22E45](#), [33C80](#)]

05E18 Group actions on combinatorial structures

05E30 Association schemes, strongly regular graphs

05E40 Combinatorial aspects of commutative algebra

05E45 Combinatorial aspects of simplicial complexes

05E99 None of the above, but in this section

06-XX Order, lattices, ordered algebraic structures [See also [18B35](#)]

06-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to ordered structures

06-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to ordered structures

06-02 Research exposition (monographs, survey articles) pertaining to ordered structures

06-03 History of ordered structures [Consider also classification numbers pertaining to [Section 01](#)]

06-04 Software, source code, etc. for problems pertaining to ordered structures

06-06 Proceedings, conferences, collections, etc. pertaining to ordered structures

06-08 Computational methods for problems pertaining to ordered structures

06-11 Research data for problems pertaining to ordered structures

06Axx Ordered sets

06A05 Total orders

06A06 Partial orders, general

06A07 Combinatorics of partially ordered sets

06A11 Algebraic aspects of posets

06A12 Semilattices [See also [20M10](#)] {For topological semilattices, see [22A26](#)}

06A15 Galois correspondences, closure operators (in relation to ordered sets)

06A75 Generalizations of ordered sets

06A99 None of the above, but in this section

06Bxx Lattices [See also [03G10](#)]

06B05 Structure theory of lattices

06B10 Lattice ideals, congruence relations

06B15 Representation theory of lattices

06B20 Varieties of lattices

06B23 Complete lattices, completions

06B25 Free lattices, projective lattices, word problems [See also [03D40](#), [08A50](#), [20F10](#)]

06B30 Topological lattices [See also [06F30](#), [22A26](#), [54F05](#), [54H12](#)]

06B35 Continuous lattices and posets, applications [See also [06B30](#), [06D10](#), [06F30](#), [18B35](#), [22A26](#), [68Q55](#)]

06B75 Generalizations of lattices

06B99 None of the above, but in this section

06Cxx Modular lattices, complemented lattices

06C05 Modular lattices, Desarguesian lattices

06C10 Semimodular lattices, geometric lattices

06C15 Complemented lattices, orthocomplemented lattices and posets [See also [03G12](#), [81P10](#)]

06C20 Complemented modular lattices, continuous geometries

06C99 None of the above, but in this section

06Dxx Distributive lattices

06D05 Structure and representation theory of distributive lattices

06D10 Complete distributivity

06D15 Pseudocomplemented lattices

06D20 Heyting algebras (lattice-theoretic aspects) [See also [03G25](#)]

06D22 Frames, locales {For topological questions, see [54-XX](#)}

06D25 Post algebras (lattice-theoretic aspects) [See also [03G20](#)]

06D30 De Morgan algebras, Łukasiewicz algebras (lattice-theoretic aspects) [See also [03G20](#)]

06D35 MV-algebras

06D50 Lattices and duality

06D72 Fuzzy lattices (soft algebras) and related topics

06D75 Other generalizations of distributive lattices

06D99 None of the above, but in this section

06Exx Boolean algebras (Boolean rings) [See also 03G05]

06E05 Structure theory of Boolean algebras

06E10 Chain conditions, complete algebras

06E15 Stone spaces (Boolean spaces) and related structures

06E20 Ring-theoretic properties of Boolean algebras [See also 16E50, 16G30]

06E25 Boolean algebras with additional operations (diagonalizable algebras, etc.) [See also 03G25, 03F45]

06E30 Boolean functions [See also 94D10]

06E75 Generalizations of Boolean algebras

06E99 None of the above, but in this section

06Fxx Ordered structures

06F05 Ordered semigroups and monoids [See also 20Mxx]

06F07 Quantaes

06F10 Noether lattices

06F15 Ordered groups [See also 20F60]

06F20 Ordered abelian groups, Riesz groups, ordered linear spaces [See also 46A40]

06F25 Ordered rings, algebras, modules {For ordered fields, see 12J15} [See also 13J25, 16W80]

06F30 Ordered topological structures (aspects of ordered structures) [See also 06B30, 22A26, 54F05, 54H12]

06F35 BCK-algebras, BCI-algebras (aspects of ordered structures) [See also 03G25]

06F99 None of the above, but in this section

08-XX General algebraic systems

08-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to general algebraic systems

08-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to general algebraic systems

08-02 Research exposition (monographs, survey articles) pertaining to general algebraic systems

08-03 History of general algebraic systems [Consider also classification numbers pertaining to Section 01]

08-04 Software, source code, etc. for problems pertaining to general algebraic systems

08-06 Proceedings, conferences, collections, etc. pertaining to general algebraic systems

08-08 Computational methods for problems pertaining to general algebraic systems

08-11 Research data for problems pertaining to general algebraic systems

08Axx Algebraic structures [See also [03C05](#)]

08A02 Relational systems, laws of composition

08A05 Structure theory of algebraic structures

08A30 Subalgebras, congruence relations

08A35 Automorphisms and endomorphisms of algebraic structures

08A40 Operations and polynomials in algebraic structures, primal algebras

08A45 Equational compactness

08A50 Word problems (aspects of algebraic structures) [See also [03D40](#), [06B25](#), [20F10](#), [68R15](#)]

08A55 Partial algebras

08A60 Unary algebras

08A62 Finitary algebras

08A65 Infinitary algebras

08A68 Heterogeneous algebras

08A70 Applications of universal algebra in computer science

08A72 Fuzzy algebraic structures

08A99 None of the above, but in this section

08Bxx Varieties [See also [03C05](#)]

08B05 Equational logic, Mal'tsev conditions

08B10 Congruence modularity, congruence distributivity

08B15 Lattices of varieties

08B20 Free algebras

08B25 Products, amalgamated products, and other kinds of limits and colimits [See also [18A30](#)]

08B26 Subdirect products and subdirect irreducibility

08B30 Injectives, projectives

08B99 None of the above, but in this section

08Cxx Other classes of algebras

08C05 Categories of algebras [See also [18C05](#)]

08C10 Axiomatic model classes [See also [03Cxx](#), in particular [03C60](#)]

08C15 Quasivarieties

08C20 Natural dualities for classes of algebras [See also [06E15](#), [18A40](#), [22A30](#)]

08C99 None of the above, but in this section

11-XX Number theory

11-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to number theory

11-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to number theory

11-02 Research exposition (monographs, survey articles) pertaining to number theory

11-03 History of number theory [Consider also classification numbers pertaining to Section [01](#)]

11-04 Software, source code, etc. for problems pertaining to number theory

11-06 Proceedings, conferences, collections, etc. pertaining to number theory

11-11 Research data for problems pertaining to number theory

11Axx Elementary number theory {For analogues in number fields, see [11R04](#)}

11A05 Multiplicative structure; Euclidean algorithm; greatest common divisors

11A07 Congruences; primitive roots; residue systems

11A15 Power residues, reciprocity

11A25 Arithmetic functions; related numbers; inversion formulas

11A41 Primes

11A51 Factorization; primality

11A55 Continued fractions {For approximation results, see [11J70](#)} [See also [11K50](#), [30B70](#), [40A15](#)]

11A63 Radix representation; digital problems {For metric results, see [11K16](#)}

11A67 Other number representations

11A99 None of the above, but in this section

11Bxx Sequences and sets

11B05 Density, gaps, topology

11B13 Additive bases, including sumsets [See also [05B10](#)]

11B25 Arithmetic progressions [See also [11N13](#)]

11B30 Arithmetic combinatorics; higher degree uniformity

11B34 Representation functions

11B37 Recurrences {For applications to special functions, see [33-XX](#)}

11B39 Fibonacci and Lucas numbers and polynomials and generalizations

11B50 Sequences (mod m)

11B57 Farey sequences; the sequences $1^k, 2^k, \dots$

11B65 Binomial coefficients; factorials; q -identities [See also [05A10](#), [05A30](#)]

11B68 Bernoulli and Euler numbers and polynomials

11B73 Bell and Stirling numbers

11B75 Other combinatorial number theory

11B83 Special sequences and polynomials

11B85 Automata sequences

11B99 None of the above, but in this section

11Cxx Polynomials and matrices

11C08 Polynomials in number theory [See also [13F20](#)]

11C20 Matrices, determinants in number theory [See also [15B36](#)]

11C99 None of the above, but in this section

11Dxx Diophantine equations [See also [11Gxx](#), [14Gxx](#)]

11D04 Linear Diophantine equations

11D07 The Frobenius problem

11D09 Quadratic and bilinear Diophantine equations

11D25 Cubic and quartic Diophantine equations

11D41 Higher degree equations; Fermat's equation

11D45 Counting solutions of Diophantine equations

11D57 Multiplicative and norm form equations

11D59 Thue-Mahler equations

11D61 Exponential Diophantine equations

11D68 Rational numbers as sums of fractions

11D72 Diophantine equations in many variables [See also [11P55](#)]

11D75 Diophantine inequalities [See also [11J25](#)]

11D79 Congruences in many variables

11D85 Representation problems [See also [11P55](#)]

11D88 p -adic and power series fields

11D99 None of the above, but in this section

11Exx Forms and linear algebraic groups [See also [19Gxx](#)] {For quadratic forms in linear algebra, see [15A63](#)}

11E04 Quadratic forms over general fields

11E08 Quadratic forms over local rings and fields

11E10 Forms over real fields

11E12 Quadratic forms over global rings and fields

11E16 General binary quadratic forms

- 11E20 General ternary and quaternary quadratic forms; forms of more than two variables
- 11E25 Sums of squares and representations by other particular quadratic forms
- 11E39 Bilinear and Hermitian forms
- 11E41 Class numbers of quadratic and Hermitian forms
- 11E45 Analytic theory (Epstein zeta functions; relations with automorphic forms and functions)
- 11E57 Classical groups [See also [14Lxx](#), [20Gxx](#)]
- 11E70 K -theory of quadratic and Hermitian forms
- 11E72 Galois cohomology of linear algebraic groups [See also [20G10](#)]
- 11E76 Forms of degree higher than two
- 11E81 Algebraic theory of quadratic forms; Witt groups and rings [See also [19G12](#), [19G24](#)]
- 11E88 Quadratic spaces; Clifford algebras [See also [15A63](#), [15A66](#)]
- 11E95 p -adic theory
- 11E99 None of the above, but in this section

- 11Fxx Discontinuous groups and automorphic forms** [See also [11R39](#), [11S37](#), [14Gxx](#), [14Kxx](#), [22E50](#), [22E55](#), [30F35](#), [32Nxx](#)] {For relations with quadratic forms, see [11E45](#)}
- 11F03 Modular and automorphic functions
- 11F06 Structure of modular groups and generalizations; arithmetic groups [See also [20H05](#), [20H10](#), [22E40](#)]
- 11F11 Holomorphic modular forms of integral weight
- 11F12 Automorphic forms, one variable
- 11F20 Dedekind eta function, Dedekind sums
- 11F22 Relationship to Lie algebras and finite simple groups
- 11F23 Relations with algebraic geometry and topology
- 11F25 Hecke-Petersson operators, differential operators (one variable)
- 11F27 Theta series; Weil representation; theta correspondences
- 11F30 Fourier coefficients of automorphic forms
- 11F32 Modular correspondences, etc.
- 11F33 Congruences for modular and p -adic modular forms [See also [14G20](#), [22E50](#)]
- 11F37 Forms of half-integer weight; nonholomorphic modular forms
- 11F41 Automorphic forms on $GL(2)$; Hilbert and Hilbert-Siegel modular groups and their modular and automorphic forms; Hilbert modular surfaces [See also [14J20](#)]
- 11F46 Siegel modular groups; Siegel and Hilbert-Siegel modular and automorphic forms
- 11F50 Jacobi forms
- 11F52 Modular forms associated to Drinfel'd modules

- 11F55** Other groups and their modular and automorphic forms (several variables)
- 11F60** Hecke-Petersson operators, differential operators (several variables)
- 11F66** Langlands L -functions; one variable Dirichlet series and functional equations
- 11F67** Special values of automorphic L -series, periods of automorphic forms, cohomology, modular symbols
- 11F68** Dirichlet series in several complex variables associated to automorphic forms; Weyl group multiple Dirichlet series
- 11F70** Representation-theoretic methods; automorphic representations over local and global fields
- 11F72** Spectral theory; trace formulas (e.g., that of Selberg)
- 11F75** Cohomology of arithmetic groups
- 11F77** Automorphic forms and their relations with perfectoid spaces [See also [14G45](#)]
- 11F80** Galois representations
- 11F85** p -adic theory, local fields [See also [14G20](#), [22E50](#)]
- 11F99** None of the above, but in this section

- 11Gxx Arithmetic algebraic geometry (Diophantine geometry)** [See also [11Dxx](#), [14Gxx](#), [14Kxx](#)]
- 11G05** Elliptic curves over global fields [See also [14H52](#)]
- 11G07** Elliptic curves over local fields [See also [14G20](#), [14H52](#)]
- 11G09** Drinfel'd modules; higher-dimensional motives, etc. [See also [14L05](#)]
- 11G10** Abelian varieties of dimension > 1 [See also [14Kxx](#)]
- 11G15** Complex multiplication and moduli of abelian varieties [See also [14K22](#)]
- 11G16** Elliptic and modular units [See also [11R27](#)]
- 11G18** Arithmetic aspects of modular and Shimura varieties [See also [14G35](#)]
- 11G20** Curves over finite and local fields [See also [14H25](#)]
- 11G25** Varieties over finite and local fields [See also [14G15](#), [14G20](#)]
- 11G30** Curves of arbitrary genus or genus $\neq 1$ over global fields [See also [14H25](#)]
- 11G32** Arithmetic aspects of dessins d'enfants, Belyĭ theory
- 11G35** Varieties over global fields [See also [14G25](#)]
- 11G40** L -functions of varieties over global fields; Birch-Swinnerton-Dyer conjecture [See also [14G10](#)]
- 11G42** Arithmetic mirror symmetry [See also [14J33](#)]
- 11G45** Geometric class field theory [See also [11R37](#), [14C35](#), [19F05](#)]
- 11G50** Heights [See also [14G40](#), [37P30](#)]
- 11G55** Polylogarithms and relations with K -theory
- 11G99** None of the above, but in this section

11Hxx Geometry of numbers {For applications in coding theory, see [94B75](#)}

11H06 Lattices and convex bodies (number-theoretic aspects) [See also [11P21](#), [52C05](#), [52C07](#)]

11H16 Nonconvex bodies

11H31 Lattice packing and covering (number-theoretic aspects) [See also [05B40](#), [52C15](#), [52C17](#)]

11H46 Products of linear forms

11H50 Minima of forms

11H55 Quadratic forms (reduction theory, extreme forms, etc.)

11H56 Automorphism groups of lattices

11H60 Mean value and transfer theorems

11H71 Relations with coding theory

11H99 None of the above, but in this section

11Jxx Diophantine approximation, transcendental number theory [See also [11K60](#)]

11J04 Homogeneous approximation to one number

11J06 Markov and Lagrange spectra and generalizations

11J13 Simultaneous homogeneous approximation, linear forms

11J17 Approximation by numbers from a fixed field

11J20 Inhomogeneous linear forms

11J25 Diophantine inequalities [See also [11D75](#)]

11J54 Small fractional parts of polynomials and generalizations

11J61 Approximation in non-Archimedean valuations

11J68 Approximation to algebraic numbers

11J70 Continued fractions and generalizations [See also [11A55](#), [11K50](#)]

11J71 Distribution modulo one [See also [11K06](#)]

11J72 Irrationality; linear independence over a field

11J81 Transcendence (general theory)

11J82 Measures of irrationality and of transcendence

11J83 Metric theory

11J85 Algebraic independence; Gel'fond's method

11J86 Linear forms in logarithms; Baker's method

11J87 Schmidt Subspace Theorem and applications

11J89 Transcendence theory of elliptic and abelian functions

11J91 Transcendence theory of other special functions

11J93 Transcendence theory of Drinfel'd and t -modules

11J95 Results involving abelian varieties

11J97 Number-theoretic analogues of methods in Nevanlinna theory (work of Vojta et al.)

11J99 None of the above, but in this section

11Kxx Probabilistic theory: distribution modulo 1; metric theory of algorithms

11K06 General theory of distribution modulo 1 [See also [11J71](#)]

11K16 Normal numbers, radix expansions, Pisot numbers, Salem numbers, good lattice points, etc. [See also [11A63](#)]

11K31 Special sequences

11K36 Well-distributed sequences and other variations

11K38 Irregularities of distribution, discrepancy [See also [11Nxx](#)]

11K41 Continuous, p -adic and abstract analogues

11K45 Pseudo-random numbers; Monte Carlo methods [See also [65C05](#), [65C10](#)]

11K50 Metric theory of continued fractions [See also [11A55](#), [11J70](#)]

11K55 Metric theory of other algorithms and expansions; measure and Hausdorff dimension [See also [11N99](#), [28Dxx](#)]

11K60 Diophantine approximation in probabilistic number theory [See also [11Jxx](#)]

11K65 Arithmetic functions in probabilistic number theory [See also [11Nxx](#)]

11K70 Harmonic analysis and almost periodicity in probabilistic number theory

11K99 None of the above, but in this section

11Lxx Exponential sums and character sums {For finite fields, see [11Txx](#)}

11L03 Trigonometric and exponential sums, general

11L05 Gauss and Kloosterman sums; generalizations

11L07 Estimates on exponential sums

11L10 Jacobsthal and Brewer sums; other complete character sums

11L15 Weyl sums

11L20 Sums over primes

11L26 Sums over arbitrary intervals

11L40 Estimates on character sums

11L99 None of the above, but in this section

11Mxx Zeta and L -functions: analytic theory

11M06 $\zeta(s)$ and $L(s, \chi)$

11M20 Real zeros of $L(s, \chi)$; results on $L(1, \chi)$

11M26 Nonreal zeros of $\zeta(s)$ and $L(s, \chi)$; Riemann and other hypotheses

11M32 Multiple Dirichlet series and zeta functions and multizeta values

11M35 Hurwitz and Lerch zeta functions

11M36 Selberg zeta functions and regularized determinants; applications to spectral theory, Dirichlet series, Eisenstein series, etc. (explicit formulas)

11M38 Zeta and L -functions in characteristic p

- 11M41 Other Dirichlet series and zeta functions {For local and global ground fields, see [11R42](#), [11R52](#), [11S40](#), [11S45](#); for algebro-geometric methods, see [14G10](#)} [See also [11E45](#), [11F66](#), [11F70](#), [11F72](#)]
- 11M45 Tauberian theorems [See also [40E05](#)]
- 11M50 Relations with random matrices
- 11M55 Relations with noncommutative geometry
- 11M99 None of the above, but in this section

11Nxx Multiplicative number theory

- 11N05 Distribution of primes
- 11N13 Primes in congruence classes
- 11N25 Distribution of integers with specified multiplicative constraints
- 11N30 Turán theory [See also [30Bxx](#)]
- 11N32 Primes represented by polynomials; other multiplicative structures of polynomial values
- 11N35 Sieves
- 11N36 Applications of sieve methods
- 11N37 Asymptotic results on arithmetic functions
- 11N45 Asymptotic results on counting functions for algebraic and topological structures
- 11N56 Rate of growth of arithmetic functions
- 11N60 Distribution functions associated with additive and positive multiplicative functions
- 11N64 Other results on the distribution of values or the characterization of arithmetic functions
- 11N69 Distribution of integers in special residue classes
- 11N75 Applications of automorphic functions and forms to multiplicative problems [See also [11Fxx](#)]
- 11N80 Generalized primes and integers
- 11N99 None of the above, but in this section

11Pxx Additive number theory; partitions

- 11P05 Waring's problem and variants
- 11P21 Lattice points in specified regions
- 11P32 Goldbach-type theorems; other additive questions involving primes
- 11P55 Applications of the Hardy-Littlewood method [See also [11D85](#)]
- 11P70 Inverse problems of additive number theory, including sumsets
- 11P81 Elementary theory of partitions [See also [05A17](#)]
- 11P82 Analytic theory of partitions
- 11P83 Partitions; congruences and congruential restrictions
- 11P84 Partition identities; identities of Rogers-Ramanujan type
- 11P99 None of the above, but in this section

- 11Rxx Algebraic number theory: global fields** {For complex multiplication, see [11G15](#)}
- 11R04** Algebraic numbers; rings of algebraic integers
- 11R06** PV-numbers and generalizations; other special algebraic numbers; Mahler measure
- 11R09** Polynomials (irreducibility, etc.)
- 11R11** Quadratic extensions
- 11R16** Cubic and quartic extensions
- 11R18** Cyclotomic extensions
- 11R20** Other abelian and metabelian extensions
- 11R21** Other number fields
- 11R23** Iwasawa theory
- 11R27** Units and factorization
- 11R29** Class numbers, class groups, discriminants
- 11R32** Galois theory
- 11R33** Integral representations related to algebraic numbers; Galois module structure of rings of integers [See also [20C10](#)]
- 11R34** Galois cohomology [See also [12Gxx](#), [19A31](#)]
- 11R37** Class field theory
- 11R39** Langlands-Weil conjectures, nonabelian class field theory [See also [11Fxx](#), [22E55](#)]
- 11R42** Zeta functions and L -functions of number fields [See also [11M41](#), [19F27](#)]
- 11R44** Distribution of prime ideals [See also [11N05](#)]
- 11R45** Density theorems
- 11R47** Other analytic theory [See also [11Nxx](#)]
- 11R52** Quaternion and other division algebras: arithmetic, zeta functions
- 11R54** Other algebras and orders, and their zeta and L -functions [See also [11S45](#), [16Hxx](#), [16Kxx](#)]
- 11R56** Adèle rings and groups
- 11R58** Arithmetic theory of algebraic function fields [See also [14-XX](#)]
- 11R59** Zeta functions and L -functions of function fields
- 11R60** Cyclotomic function fields (class groups, Bernoulli objects, etc.)
- 11R65** Class groups and Picard groups of orders
- 11R70** K -theory of global fields [See also [19Fxx](#)]
- 11R80** Totally real fields [See also [12J15](#)]
- 11R99** None of the above, but in this section

11Sxx Algebraic number theory: local and p -adic fields

11S05 Polynomials

11S15 Ramification and extension theory

11S20 Galois theory

11S23 Integral representations

11S25 Galois cohomology [See also [12Gxx](#), [16H05](#)]

11S31 Class field theory; p -adic formal groups [See also [14L05](#)]

11S37 Langlands-Weil conjectures, nonabelian class field theory [See also [11Fxx](#), [22E50](#)]

11S40 Zeta functions and L -functions [See also [11M41](#), [19F27](#)]

11S45 Algebras and orders, and their zeta functions [See also [11R52](#), [11R54](#), [16Hxx](#), [16Kxx](#)]

11S70 K -theory of local fields [See also [19Fxx](#)]

11S80 Other analytic theory (analogues of beta and gamma functions, p -adic integration, etc.)

11S82 Non-Archimedean dynamical systems [See mainly [37Pxx](#)]

11S85 Other nonanalytic theory

11S90 Prehomogeneous vector spaces

11S99 None of the above, but in this section

11Txx Finite fields and commutative rings (number-theoretic aspects)

11T06 Polynomials over finite fields

11T22 Cyclotomy

11T23 Exponential sums

11T24 Other character sums and Gauss sums

11T30 Structure theory for finite fields and commutative rings, number-theoretic aspects

11T55 Arithmetic theory of polynomial rings over finite fields

11T60 Finite upper half-planes

11T71 Algebraic coding theory; cryptography (number-theoretic aspects)

11T99 None of the above, but in this section

11Uxx Connections of number theory and logic

11U05 Decidability (number-theoretic aspects) [See also [03B25](#)]

11U07 Ultraproducts (number-theoretic aspects) [See also [03C20](#)]

11U09 Model theory (number-theoretic aspects) [See also [03Cxx](#)]

11U10 Nonstandard arithmetic (number-theoretic aspects) [See also [03H15](#)]

11U99 None of the above, but in this section

11Yxx Computational number theory {For software etc., see [11-04](#)}

11Y05 Factorization

11Y11 Primality

11Y16 Number-theoretic algorithms; complexity [See also [68Q25](#)]

11Y35 Analytic computations

11Y40 Algebraic number theory computations

11Y50 Computer solution of Diophantine equations

11Y55 Calculation of integer sequences

11Y60 Evaluation of number-theoretic constants

11Y65 Continued fraction calculations (number-theoretic aspects)

11Y70 Values of arithmetic functions; tables

11Y99 None of the above, but in this section

11Zxx Miscellaneous applications of number theory

11Z05 Miscellaneous applications of number theory

11Z99 None of the above, but in this section

12-XX Field theory and polynomials

12-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to field theory

12-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to field theory

12-02 Research exposition (monographs, survey articles) pertaining to field theory

12-03 History of field theory [Consider also classification numbers pertaining to Section [01](#)]

12-04 Software, source code, etc. for problems pertaining to field theory

12-06 Proceedings, conferences, collections, etc. pertaining to field theory

12-08 Computational methods for problems pertaining to field theory

12-11 Research data for problems pertaining to field theory

12Dxx Real and complex fields

12D05 Polynomials in real and complex fields: factorization

12D10 Polynomials in real and complex fields: location of zeros (algebraic theorems) {For the analytic theory, see [26C10](#), [30C15](#)}

12D15 Fields related with sums of squares (formally real fields, Pythagorean fields, etc.) [See also [11Exx](#)]

12D99 None of the above, but in this section

12Exx General field theory

- 12E05** Polynomials in general fields (irreducibility, etc.)
- 12E10** Special polynomials in general fields
- 12E12** Equations in general fields
- 12E15** Skew fields, division rings [See also [11R52](#), [11R54](#), [11S45](#), [16Kxx](#)]
- 12E20** Finite fields (field-theoretic aspects)
- 12E25** Hilbertian fields; Hilbert's irreducibility theorem
- 12E30** Field arithmetic
- 12E99** None of the above, but in this section

12Fxx Field extensions

- 12F05** Algebraic field extensions
- 12F10** Separable extensions, Galois theory
- 12F12** Inverse Galois theory
- 12F15** Inseparable field extensions
- 12F20** Transcendental field extensions
- 12F99** None of the above, but in this section

12Gxx Homological methods (field theory)

- 12G05** Galois cohomology [See also [14F22](#), [16Hxx](#), [16K50](#)]
- 12G10** Cohomological dimension of fields
- 12G99** None of the above, but in this section

12Hxx Differential and difference algebra

- 12H05** Differential algebra [See also [13Nxx](#)]
- 12H10** Difference algebra [See also [39Axx](#)]
- 12H20** Abstract differential equations [See also [34Mxx](#)]
- 12H25** p -adic differential equations [See also [11S80](#), [14G20](#)]
- 12H99** None of the above, but in this section

12Jxx Topological fields

12J05 Normed fields

12J10 Valued fields

12J12 Formally p -adic fields

12J15 Ordered fields

12J17 Topological semifields

12J20 General valuation theory for fields [See also [13A18](#)]

12J25 Non-Archimedean valued fields [See also [30G06](#), [32P05](#), [46S10](#), [47S10](#)]

12J27 Krasner-Tate algebras [See mainly [32P05](#); see also [46S10](#), [47S10](#)]

12J99 None of the above, but in this section

12Kxx Generalizations of fields

12K05 Near-fields [See also [16Y30](#)]

12K10 Semifields [See also [16Y60](#)]

12K99 None of the above, but in this section

12Lxx Connections between field theory and logic

12L05 Decidability and field theory [See also [03B25](#)]

12L10 Ultraproducts and field theory [See also [03C20](#)]

12L12 Model theory of fields [See also [03C60](#)]

12L15 Nonstandard arithmetic and field theory [See also [03H15](#)]

12L99 None of the above, but in this section

13-XX Commutative algebra

13-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to commutative algebra

13-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to commutative algebra

13-02 Research exposition (monographs, survey articles) pertaining to commutative algebra

13-03 History of commutative algebra [Consider also classification numbers pertaining to [Section 01](#)]

13-04 Software, source code, etc. for problems pertaining to commutative algebra

13-06 Proceedings, conferences, collections, etc. pertaining to commutative algebra

13-11 Research data for problems pertaining to commutative algebra

13Axx General commutative ring theory

- 13A02** Graded rings [See also [16W50](#)]
- 13A05** Divisibility and factorizations in commutative rings [See also [13F15](#)]
- 13A15** Ideals and multiplicative ideal theory in commutative rings
- 13A18** Valuations and their generalizations for commutative rings [See also [12J20](#)]
- 13A30** Associated graded rings of ideals (Rees ring, form ring), analytic spread and related topics
- 13A35** Characteristic p methods (Frobenius endomorphism) and reduction to characteristic p ; tight closure [See also [13B22](#)]
- 13A50** Actions of groups on commutative rings; invariant theory [See also [14L24](#)]
- 13A70** General commutative ring theory and combinatorics (zero-divisor graphs, annihilating-ideal graphs, etc.) [See also [05C25](#), [05E40](#)]
- 13A99** None of the above, but in this section

13Bxx Commutative ring extensions and related topics

- 13B02** Extension theory of commutative rings
- 13B05** Galois theory and commutative ring extensions
- 13B10** Morphisms of commutative rings
- 13B21** Integral dependence in commutative rings; going up, going down
- 13B22** Integral closure of commutative rings and ideals [See also [13A35](#)]; integrally closed rings, related rings (Japanese, etc.)
- 13B25** Polynomials over commutative rings [See also [11C08](#), [11T06](#), [13F20](#), [13M10](#)]
- 13B30** Rings of fractions and localization for commutative rings [See also [16S85](#)]
- 13B35** Completion of commutative rings [See also [13J10](#)]
- 13B40** Étale and flat extensions; Henselization; Artin approximation [See also [13J15](#), [14B12](#), [14B25](#)]
- 13B99** None of the above, but in this section

13Cxx Theory of modules and ideals in commutative rings

- 13C05** Structure, classification theorems for modules and ideals in commutative rings
- 13C10** Projective and free modules and ideals in commutative rings [See also [19A13](#)]
- 13C11** Injective and flat modules and ideals in commutative rings
- 13C12** Torsion modules and ideals in commutative rings
- 13C13** Other special types of modules and ideals in commutative rings
- 13C14** Cohen-Macaulay modules [See also [13H10](#)]
- 13C15** Dimension theory, depth, related commutative rings (catenary, etc.)
- 13C20** Class groups [See also [11R29](#)]
- 13C40** Linkage, complete intersections and determinantal ideals [See also [14M06](#), [14M10](#), [14M12](#)]

13C60 Module categories and commutative rings

13C70 Theory of modules and ideals in commutative rings described by combinatorial properties [See also [05C25](#), [05E40](#)]

13C99 None of the above, but in this section

13Dxx Homological methods in commutative ring theory {For noncommutative rings, see [16Exx](#); for general categories, see [18Gxx](#)}

13D02 Syzygies, resolutions, complexes and commutative rings

13D03 (Co)homology of commutative rings and algebras (e.g., Hochschild, André-Quillen, cyclic, dihedral, etc.)

13D05 Homological dimension and commutative rings

13D07 Homological functors on modules of commutative rings (Tor, Ext, etc.)

13D09 Derived categories and commutative rings

13D10 Deformations and infinitesimal methods in commutative ring theory [See also [14B10](#), [14B12](#), [14D15](#), [32Gxx](#)]

13D15 Grothendieck groups, K -theory and commutative rings [See also [14C35](#), [18F30](#), [19Axx](#), [19D50](#)]

13D22 Homological conjectures (intersection theorems) in commutative ring theory

13D30 Torsion theory for commutative rings [See also [13C12](#), [18E40](#)]

13D40 Hilbert-Samuel and Hilbert-Kunz functions; Poincaré series

13D45 Local cohomology and commutative rings [See also [14B15](#)]

13D99 None of the above, but in this section

13Exx Chain conditions, finiteness conditions in commutative ring theory

13E05 Commutative Noetherian rings and modules

13E10 Commutative Artinian rings and modules, finite-dimensional algebras

13E15 Commutative rings and modules of finite generation or presentation; number of generators

13E99 None of the above, but in this section

13Fxx Arithmetic rings and other special commutative rings

13F05 Dedekind, Prüfer, Krull and Mori rings and their generalizations

13F07 Euclidean rings and generalizations

13F10 Principal ideal rings

13F15 Commutative rings defined by factorization properties (e.g., atomic, factorial, half-factorial) [See also [13A05](#), [14M05](#)]

13F20 Polynomial rings and ideals; rings of integer-valued polynomials [See also [11C08](#), [13B25](#)]

13F25 Formal power series rings [See also [13J05](#)]

13F30 Valuation rings [See also [13A18](#)]

13F35 Witt vectors and related rings

- 13F40** Excellent rings
- 13F45** Seminormal rings
- 13F50** Rings with straightening laws, Hodge algebras
- 13F55** Commutative rings defined by monomial ideals; Stanley-Reisner face rings; simplicial complexes [See also [55U10](#)]
- 13F60** Cluster algebras
- 13F65** Commutative rings defined by binomial ideals, toric rings, etc. [See also [14M25](#)]
- 13F70** Other commutative rings defined by combinatorial properties
- 13F99** None of the above, but in this section

- 13Gxx Integral domains**
- 13G05** Integral domains
- 13G99** None of the above, but in this section

- 13Hxx Local rings and semilocal rings**
- 13H05** Regular local rings
- 13H10** Special types (Cohen-Macaulay, Gorenstein, Buchsbaum, etc.) [See also [14M05](#)]
- 13H15** Multiplicity theory and related topics [See also [14C17](#)]
- 13H99** None of the above, but in this section

- 13Jxx Topological rings and modules** [See also [16W60](#), [16W80](#)]
- 13J05** Power series rings [See also [13F25](#)]
- 13J07** Analytical algebras and rings [See also [32B05](#)]
- 13J10** Complete rings, completion [See also [13B35](#)]
- 13J15** Henselian rings [See also [13B40](#)]
- 13J20** Global topological rings
- 13J25** Ordered rings [See also [06F25](#)]
- 13J30** Real algebra [See also [12D15](#), [14Pxx](#)]
- 13J99** None of the above, but in this section

- 13Lxx Applications of logic to commutative algebra** [See also [03Cxx](#), [03Hxx](#)]
- 13L05** Applications of logic to commutative algebra [See also [03Cxx](#), [03Hxx](#)]
- 13L99** None of the above, but in this section

- 13Mxx Finite commutative rings** {For number-theoretic aspects, see [11Txx](#)}
- 13M05** Structure of finite commutative rings
- 13M10** Polynomials and finite commutative rings
- 13M99** None of the above, but in this section

13Nxx Differential algebra [See also [12H05](#), [14F10](#)]

13N05 Modules of differentials

13N10 Commutative rings of differential operators and their modules [See also [16S32](#), [32C38](#)]

13N15 Derivations and commutative rings

13N99 None of the above, but in this section

13Pxx Computational aspects and applications of commutative rings [See also [14Qxx](#), [68W30](#)] {For software etc., see [13-04](#)}

13P05 Polynomials, factorization in commutative rings [See also [12-08](#)]

13P10 Gröbner bases; other bases for ideals and modules (e.g., Janet and border bases)

13P15 Solving polynomial systems; resultants

13P20 Computational homological algebra [See also [13Dxx](#)]

13P25 Applications of commutative algebra (e.g., to statistics, control theory, optimization, etc.)

13P99 None of the above, but in this section

14-XX Algebraic geometry

14-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to algebraic geometry

14-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to algebraic geometry

14-02 Research exposition (monographs, survey articles) pertaining to algebraic geometry

14-03 History of algebraic geometry [Consider also classification numbers pertaining to Section [01](#)]

14-04 Software, source code, etc. for problems pertaining to algebraic geometry

14-06 Proceedings, conferences, collections, etc. pertaining to algebraic geometry

14-11 Research data for problems pertaining to algebraic geometry

14Axx Foundations of algebraic geometry

14A05 Relevant commutative algebra [See also [13-XX](#)]

14A10 Varieties and morphisms

14A15 Schemes and morphisms

14A20 Generalizations (algebraic spaces, stacks)

14A21 Logarithmic algebraic geometry, log schemes

14A22 Noncommutative algebraic geometry [See also [16S38](#)]

14A23 Geometry over the field with one element

14A25 Elementary questions in algebraic geometry

14A30 Fundamental constructions in algebraic geometry involving higher and derived categories (homotopical algebraic geometry, derived algebraic geometry, etc.) {For categorical aspects, see [18Fxx](#), [18Gxx](#)}

14A99 None of the above, but in this section

14Bxx Local theory in algebraic geometry

- 14B05 Singularities in algebraic geometry [See also [14E15](#), [14H20](#), [14J17](#), [32Sxx](#), [58Kxx](#)]
- 14B07 Deformations of singularities [See also [14D15](#), [32S30](#)]
- 14B10 Infinitesimal methods in algebraic geometry [See also [13D10](#)]
- 14B12 Local deformation theory, Artin approximation, etc. [See also [13B40](#), [13D10](#)]
- 14B15 Local cohomology and algebraic geometry [See also [13D45](#), [32C36](#)]
- 14B20 Formal neighborhoods in algebraic geometry
- 14B25 Local structure of morphisms in algebraic geometry: étale, flat, etc. [See also [13B40](#)]
- 14B99 None of the above, but in this section

14Cxx Cycles and subschemes

- 14C05 Parametrization (Chow and Hilbert schemes)
- 14C15 (Equivariant) Chow groups and rings; motives
- 14C17 Intersection theory, characteristic classes, intersection multiplicities in algebraic geometry [See also [13H15](#)]
- 14C20 Divisors, linear systems, invertible sheaves
- 14C21 Pencils, nets, webs in algebraic geometry [See also [53A60](#)]
- 14C22 Picard groups
- 14C25 Algebraic cycles
- 14C30 Transcendental methods, Hodge theory (algebraic-geometric aspects) [See also [14D07](#), [32G20](#), [32J25](#), [32S35](#)], Hodge conjecture
- 14C34 Torelli problem [See also [32G20](#)]
- 14C35 Applications of methods of algebraic K -theory in algebraic geometry [See also [19Exx](#)]
- 14C40 Riemann-Roch theorems [See also [19E20](#), [19L10](#)]
- 14C99 None of the above, but in this section

14Dxx Families, fibrations in algebraic geometry

- 14D05 Structure of families (Picard-Lefschetz, monodromy, etc.)
- 14D06 Fibrations, degenerations in algebraic geometry
- 14D07 Variation of Hodge structures (algebraic-geometric aspects) [See also [32G20](#)]
- 14D10 Arithmetic ground fields (finite, local, global) and families or fibrations
- 14D15 Formal methods and deformations in algebraic geometry [See also [13D10](#), [14B07](#), [32Gxx](#)]
- 14D20 Algebraic moduli problems, moduli of vector bundles {For analytic moduli problems, see [32G13](#)}
- 14D21 Applications of vector bundles and moduli spaces in mathematical physics (twistor theory, instantons, quantum field theory) [See also [32L25](#), [81Txx](#)]
- 14D22 Fine and coarse moduli spaces
- 14D23 Stacks and moduli problems
- 14D24 Geometric Langlands program (algebraic-geometric aspects) [See also [22E57](#)]
- 14D99 None of the above, but in this section

14Exx Birational geometry

14E05 Rational and birational maps

14E07 Birational automorphisms, Cremona group and generalizations

14E08 Rationality questions in algebraic geometry [See also [14M20](#)]

14E15 Global theory and resolution of singularities (algebraic-geometric aspects) [See also [14B05](#), [32S20](#), [32S45](#)]

14E16 McKay correspondence

14E18 Arcs and motivic integration

14E20 Coverings in algebraic geometry [See also [14H30](#)]

14E22 Ramification problems in algebraic geometry [See also [11S15](#)]

14E25 Embeddings in algebraic geometry

14E30 Minimal model program (Mori theory, extremal rays)

14E99 None of the above, but in this section

14Fxx (Co)homology theory in algebraic geometry [See also [13Dxx](#)]

14F06 Sheaves in algebraic geometry [See also [14F07](#), [14H60](#), [14J60](#), [18F20](#), [32Lxx](#), [46M20](#)]

14F07 Derived categories of sheaves, dg categories, and related constructions in algebraic geometry [See also [14A30](#), [14F06](#), [18Gxx](#)]

14F10 Differentials and other special sheaves; D-modules; Bernstein-Sato ideals and polynomials [See also [13Nxx](#), [32C38](#)]

14F17 Vanishing theorems in algebraic geometry [See also [32L20](#)]

14F18 Multiplier ideals

14F20 Étale and other Grothendieck topologies and (co)homologies

14F22 Brauer groups of schemes [See also [12G05](#), [16K50](#)]

14F25 Classical real and complex (co)homology in algebraic geometry

14F30 p -adic cohomology, crystalline cohomology

14F35 Homotopy theory and fundamental groups in algebraic geometry [See also [14H30](#)]

14F40 de Rham cohomology and algebraic geometry [See also [14C30](#), [32C35](#), [32L10](#)]

14F42 Motivic cohomology; motivic homotopy theory [See also [19E15](#)]

14F43 Other algebraic-geometric (co)homologies (e.g., intersection, equivariant, Lawson, Deligne (co)homologies)

14F45 Topological properties in algebraic geometry

14F99 None of the above, but in this section

14Gxx Arithmetic problems in algebraic geometry; Diophantine geometry [See also [11Dxx](#), [11Gxx](#)]

14G05 Rational points

14G10 Zeta functions and related questions in algebraic geometry (e.g., Birch-Swinnerton-Dyer conjecture) [See also [11G40](#)]

14G12 Hasse principle, weak and strong approximation, Brauer-Manin obstruction [See also [14F22](#)]

14G15 Finite ground fields in algebraic geometry

14G17 Positive characteristic ground fields in algebraic geometry

14G20 Local ground fields in algebraic geometry

14G22 Rigid analytic geometry

14G25 Global ground fields in algebraic geometry

14G27 Other nonalgebraically closed ground fields in algebraic geometry

14G32 Universal profinite groups (relationship to moduli spaces, projective and moduli towers, Galois theory)

14G35 Modular and Shimura varieties [See also [11F41](#), [11F46](#), [11G18](#)]

14G40 Arithmetic varieties and schemes; Arakelov theory; heights [See also [11G50](#), [37P30](#)]

14G45 Perfectoid spaces and mixed characteristic

14G50 Applications to coding theory and cryptography of arithmetic geometry [See also [94A60](#), [94B27](#), [94B40](#)]

14G99 None of the above, but in this section

14Hxx Curves in algebraic geometry

14H05 Algebraic functions and function fields in algebraic geometry [See also [11R58](#)]

14H10 Families, moduli of curves (algebraic)

14H15 Families, moduli of curves (analytic) [See also [30F10](#), [32G15](#)]

14H20 Singularities of curves, local rings [See also [13Hxx](#), [14B05](#)]

14H25 Arithmetic ground fields for curves [See also [11Dxx](#), [11G05](#), [14Gxx](#)]

14H30 Coverings of curves, fundamental group [See also [14E20](#), [14F35](#)]

14H37 Automorphisms of curves

14H40 Jacobians, Prym varieties [See also [32G20](#)]

14H42 Theta functions and curves; Schottky problem [See also [14K25](#), [32G20](#)]

14H45 Special algebraic curves and curves of low genus

14H50 Plane and space curves

14H51 Special divisors on curves (gonality, Brill-Noether theory)

14H52 Elliptic curves [See also [11G05](#), [11G07](#), [14Kxx](#)]

14H55 Riemann surfaces; Weierstrass points; gap sequences [See also [30Fxx](#)]

- 14H57** Dessins d'enfants theory {For arithmetic aspects, see [11G32](#)}
- 14H60** Vector bundles on curves and their moduli [See also [14D20](#), [14F06](#), [14J60](#)]
- 14H70** Relationships between algebraic curves and integrable systems
- 14H81** Relationships between algebraic curves and physics
- 14H99** None of the above, but in this section

- 14Jxx Surfaces and higher-dimensional varieties** {For analytic theory, see [32Jxx](#)}
- 14J10** Families, moduli, classification: algebraic theory
- 14J15** Moduli, classification: analytic theory; relations with modular forms [See also [32G13](#)]
- 14J17** Singularities of surfaces or higher-dimensional varieties [See also [14B05](#), [14E15](#), [32S05](#), [32S25](#)]
- 14J20** Arithmetic ground fields for surfaces or higher-dimensional varieties [See also [11Dxx](#), [11G25](#), [11G35](#), [14Gxx](#)]
- 14J25** Special surfaces {For Hilbert modular surfaces, see [14G35](#)}
- 14J26** Rational and ruled surfaces
- 14J27** Elliptic surfaces, elliptic or Calabi-Yau fibrations
- 14J28** $K3$ surfaces and Enriques surfaces
- 14J29** Surfaces of general type
- 14J30** 3-folds
- 14J32** Calabi-Yau manifolds (algebraic-geometric aspects) [See also [32Q25](#)]
- 14J33** Mirror symmetry (algebraic-geometric aspects) [See also [11G42](#), [53D37](#)]
- 14J35** 4-folds
- 14J40** n -folds ($n > 4$)
- 14J42** Holomorphic symplectic varieties, hyper-Kähler varieties
- 14J45** Fano varieties
- 14J50** Automorphisms of surfaces and higher-dimensional varieties
- 14J60** Vector bundles on surfaces and higher-dimensional varieties, and their moduli [See also [14D20](#), [14F06](#), [14H60](#), [32Lxx](#)]
- 14J70** Hypersurfaces and algebraic geometry
- 14J80** Topology of surfaces (Donaldson polynomials, Seiberg-Witten invariants)
- 14J81** Relationships with physics
- 14J99** None of the above, but in this section

14Kxx Abelian varieties and schemes

14K02 Isogeny

14K05 Algebraic theory of abelian varieties

14K10 Algebraic moduli of abelian varieties, classification [See also [11G15](#)]

14K12 Subvarieties of abelian varieties

14K15 Arithmetic ground fields for abelian varieties [See also [11Dxx](#), [11Fxx](#), [11G10](#), [14Gxx](#)]

14K20 Analytic theory of abelian varieties; abelian integrals and differentials

14K22 Complex multiplication and abelian varieties [See also [11G15](#)]

14K25 Theta functions and abelian varieties [See also [14H42](#)]

14K30 Picard schemes, higher Jacobians [See also [14H40](#), [32G20](#)]

14K99 None of the above, but in this section

14Lxx Algebraic groups {For linear algebraic groups, see [20Gxx](#); for Lie algebras, see [17B45](#)}

14L05 Formal groups, p -divisible groups [See also [55N22](#)]

14L10 Group varieties

14L15 Group schemes

14L17 Affine algebraic groups, hyperalgebra constructions [See also [17B45](#), [18C40](#)]

14L24 Geometric invariant theory [See also [13A50](#)]

14L30 Group actions on varieties or schemes (quotients) [See also [13A50](#), [14L24](#), [14M17](#)]

14L35 Classical groups (algebraic-geometric aspects) [See also [20Gxx](#), [51N30](#)]

14L40 Other algebraic groups (geometric aspects)

14L99 None of the above, but in this section

14Mxx Special varieties

14M05 Varieties defined by ring conditions (factorial, Cohen-Macaulay, seminormal) [See also [13F15](#), [13F45](#), [13H10](#)]

14M06 Linkage [See also [13C40](#)]

14M07 Low codimension problems in algebraic geometry

14M10 Complete intersections [See also [13C40](#)]

14M12 Determinantal varieties [See also [13C40](#)]

14M15 Grassmannians, Schubert varieties, flag manifolds [See also [32M10](#), [51M35](#)]

14M17 Homogeneous spaces and generalizations [See also [32M10](#), [53C30](#), [57T15](#)]

14M20 Rational and unirational varieties [See also [14E08](#)]

14M22 Rationally connected varieties

14M25 Toric varieties, Newton polyhedra, Okounkov bodies [See also [52B20](#)]

14M27 Compactifications; symmetric and spherical varieties

14M30 Supervarieties [See also [32C11](#), [58A50](#)]

14M35 Character varieties

14M99 None of the above, but in this section

14Nxx Projective and enumerative algebraic geometry [See also [51-XX](#)]

14N05 Projective techniques in algebraic geometry [See also [51N35](#)]

14N07 Secant varieties, tensor rank, varieties of sums of powers

14N10 Enumerative problems (combinatorial problems) in algebraic geometry

14N15 Classical problems, Schubert calculus

14N20 Configurations and arrangements of linear subspaces

14N25 Varieties of low degree

14N30 Adjunction problems

14N35 Gromov-Witten invariants, quantum cohomology, Gopakumar-Vafa invariants, Donaldson-Thomas invariants (algebraic-geometric aspects) [See also [53D45](#)]

14N99 None of the above, but in this section

14Pxx Real algebraic and real-analytic geometry

14P05 Real algebraic sets [See also [12D15](#), [13J30](#)]

14P10 Semialgebraic sets and related spaces

14P15 Real-analytic and semi-analytic sets [See also [32B20](#), [32C05](#)]

14P20 Nash functions and manifolds [See also [32C07](#), [58A07](#)]

14P25 Topology of real algebraic varieties

14P99 None of the above, but in this section

14Qxx Computational aspects in algebraic geometry {For software etc., see [14-04](#)} [See also [12-08](#), [13Pxx](#), [68W30](#)]

14Q05 Computational aspects of algebraic curves [See also [14Hxx](#)]

14Q10 Computational aspects of algebraic surfaces [See also [14Jxx](#)]

14Q15 Computational aspects of higher-dimensional varieties [See also [14Jxx](#), [14Mxx](#)]

14Q20 Effectivity, complexity and computational aspects of algebraic geometry

14Q25 Computational algebraic geometry over arithmetic ground fields [See also [14Gxx](#), [14H25](#), [14Kxx](#)]

14Q30 Computational real algebraic geometry [See also [14Pxx](#)]

14Q65 Geometric aspects of numerical algebraic geometry [See also [65H14](#)]

14Q99 None of the above, but in this section

14Rxx Affine geometry

14R05 Classification of affine varieties

14R10 Affine spaces (automorphisms, embeddings, exotic structures, cancellation problem)

14R15 Jacobian problem [See also [13F20](#)]

14R20 Group actions on affine varieties [See also [13A50](#), [14L30](#)]

14R25 Affine fibrations [See also [14D06](#)]

14R99 None of the above, but in this section

14Txx Tropical geometry [See also [12K10](#), [14M25](#), [14N10](#), [52B20](#)]

14T10 Foundations of tropical geometry and relations with algebra {For algebraic aspects, see [15A80](#)}

14T15 Combinatorial aspects of tropical varieties

14T20 Geometric aspects of tropical varieties

14T25 Arithmetic aspects of tropical varieties

14T90 Applications of tropical geometry

14T99 None of the above, but in this section

15-XX Linear and multilinear algebra; matrix theory

15-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to linear algebra

15-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to linear algebra

15-02 Research exposition (monographs, survey articles) pertaining to linear algebra

15-03 History of linear algebra [Consider also classification numbers pertaining to Section [01](#)]

15-04 Software, source code, etc. for problems pertaining to linear algebra

15-06 Proceedings, conferences, collections, etc. pertaining to linear algebra

15-11 Research data for problems pertaining to linear algebra

15Axx Basic linear algebra

15A03 Vector spaces, linear dependence, rank, lineability

15A04 Linear transformations, semilinear transformations

15A06 Linear equations (linear algebraic aspects)

15A09 Theory of matrix inversion and generalized inverses

15A10 Applications of generalized inverses

15A12 Conditioning of matrices [See also [65F35](#)]

15A15 Determinants, permanents, traces, other special matrix functions [See also [19B10](#), [19B14](#)]

15A16 Matrix exponential and similar functions of matrices

15A18 Eigenvalues, singular values, and eigenvectors

- 15A20 Diagonalization, Jordan forms
- 15A21 Canonical forms, reductions, classification
- 15A22 Matrix pencils [See also [47A56](#)]
- 15A23 Factorization of matrices
- 15A24 Matrix equations and identities
- 15A27 Commutativity of matrices
- 15A29 Inverse problems in linear algebra
- 15A30 Algebraic systems of matrices [See also [16S50](#), [20Gxx](#), [20Hxx](#)]
- 15A39 Linear inequalities of matrices
- 15A42 Inequalities involving eigenvalues and eigenvectors
- 15A45 Miscellaneous inequalities involving matrices
- 15A54 Matrices over function rings in one or more variables
- 15A60 Norms of matrices, numerical range, applications of functional analysis to matrix theory [See also [65F35](#), [65J05](#)]
- 15A63 Quadratic and bilinear forms, inner products [See mainly [11Exx](#)]
- 15A66 Clifford algebras, spinors
- 15A67 Applications of Clifford algebras to physics, etc.
- 15A69 Multilinear algebra, tensor calculus
- 15A72 Vector and tensor algebra, theory of invariants [See also [13A50](#), [14L24](#)]
- 15A75 Exterior algebra, Grassmann algebras
- 15A78 Other algebras built from modules
- 15A80 Max-plus and related algebras
- 15A83 Matrix completion problems
- 15A86 Linear preserver problems
- 15A99 None of the above, but in this section

15Bxx Special matrices

- 15B05 Toeplitz, Cauchy, and related matrices
- 15B10 Orthogonal matrices
- 15B15 Fuzzy matrices
- 15B30 Matrix Lie algebras
- 15B33 Matrices over special rings (quaternions, finite fields, etc.)
- 15B34 Boolean and Hadamard matrices
- 15B35 Sign pattern matrices

- 15B36** Matrices of integers [See also [11C20](#)]
- 15B48** Positive matrices and their generalizations; cones of matrices
- 15B51** Stochastic matrices
- 15B52** Random matrices (algebraic aspects) {For probabilistic aspects, see [60B20](#)}
- 15B57** Hermitian, skew-Hermitian, and related matrices
- 15B99** None of the above, but in this section

16-XX Associative rings and algebras {For the commutative case, see [13-XX](#)}

- 16-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to associative rings and algebras
- 16-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to associative rings and algebras
- 16-02** Research exposition (monographs, survey articles) pertaining to associative rings and algebras
- 16-03** History of associative rings and algebras [Consider also classification numbers pertaining to [Section 01](#)]
- 16-04** Software, source code, etc. for problems pertaining to associative rings and algebras
- 16-06** Proceedings, conferences, collections, etc. pertaining to associative rings and algebras
- 16-11** Research data for problems pertaining to associative rings and algebras

16Bxx General and miscellaneous

- 16B50** Category-theoretic methods and results in associative algebras (except as in [16D90](#)) [See also [18-XX](#)]
- 16B70** Applications of logic in associative algebras [See also [03Cxx](#)]
- 16B99** None of the above, but in this section

16Dxx Modules, bimodules and ideals in associative algebras

- 16D10** General module theory in associative algebras
- 16D20** Bimodules in associative algebras
- 16D25** Ideals in associative algebras
- 16D30** Infinite-dimensional simple rings (except as in [16Kxx](#))
- 16D40** Free, projective, and flat modules and ideals in associative algebras [See also [19A13](#)]
- 16D50** Injective modules, self-injective associative rings [See also [16L60](#)]
- 16D60** Simple and semisimple modules, primitive rings and ideals in associative algebras
- 16D70** Structure and classification for modules, bimodules and ideals (except as in [16Gxx](#)), direct sum decomposition and cancellation in associative algebras)
- 16D80** Other classes of modules and ideals in associative algebras [See also [16G50](#)]
- 16D90** Module categories in associative algebras [See also [16Gxx](#), [16S90](#)]; module theory in a category-theoretic context; Morita equivalence and duality
- 16D99** None of the above, but in this section

16Exx Homological methods in associative algebras {For commutative rings, see [13Dxx](#); for general categories, see [18Gxx](#)}

16E05 Syzygies, resolutions, complexes in associative algebras

16E10 Homological dimension in associative algebras

16E20 Grothendieck groups, K -theory, etc. [See also [18F30](#), [19Axx](#), [19D50](#)]

16E30 Homological functors on modules (Tor, Ext, etc.) in associative algebras

16E35 Derived categories and associative algebras

16E40 (Co)homology of rings and associative algebras (e.g., Hochschild, cyclic, dihedral, etc.)

16E45 Differential graded algebras and applications (associative algebraic aspects)

16E50 von Neumann regular rings and generalizations (associative algebraic aspects)

16E60 Semihereditary and hereditary rings, free ideal rings, Sylvester rings, etc.

16E65 Homological conditions on associative rings (generalizations of regular, Gorenstein, Cohen-Macaulay rings, etc.)

16E99 None of the above, but in this section

16Gxx Representation theory of associative rings and algebras

16G10 Representations of associative Artinian rings

16G20 Representations of quivers and partially ordered sets

16G30 Representations of orders, lattices, algebras over commutative rings [See also [16Hxx](#)]

16G50 Cohen-Macaulay modules in associative algebras

16G60 Representation type (finite, tame, wild, etc.) of associative algebras

16G70 Auslander-Reiten sequences (almost split sequences) and Auslander-Reiten quivers

16G99 None of the above, but in this section

16Hxx Associative algebras and orders {For arithmetic aspects, see [11R52](#), [11R54](#), [11S45](#); for representation theory, see [16G30](#)}

16H05 Separable algebras (e.g., quaternion algebras, Azumaya algebras, etc.)

16H10 Orders in separable algebras

16H15 Commutative orders

16H20 Lattices over orders

16H99 None of the above, but in this section

16Kxx Division rings and semisimple Artin rings [See also [12E15](#), [15A30](#)]

16K20 Finite-dimensional division rings {For crossed products, see [16S35](#)}

16K40 Infinite-dimensional and general division rings

16K50 Brauer groups (algebraic aspects) [See also [12G05](#), [14F22](#)]

16K99 None of the above, but in this section

16Lxx Local rings and generalizations

16L30 Noncommutative local and semilocal rings, perfect rings

16L60 Quasi-Frobenius rings [See also [16D50](#)]

16L99 None of the above, but in this section

16Nxx Radicals and radical properties of associative rings

16N20 Jacobson radical, quasimultiplication

16N40 Nil and nilpotent radicals, sets, ideals, associative rings

16N60 Prime and semiprime associative rings [See also [16D60](#), [16U10](#)]

16N80 General radicals and associative rings {For radicals in module categories, see [16S90](#)}

16N99 None of the above, but in this section

16Pxx Chain conditions, growth conditions, and other forms of finiteness for associative rings and algebras

16P10 Finite rings and finite-dimensional associative algebras {For semisimple, see [16K20](#); for commutative, see [11Txx](#), [13Mxx](#)}

16P20 Artinian rings and modules (associative rings and algebras)

16P40 Noetherian rings and modules (associative rings and algebras)

16P50 Localization and associative Noetherian rings [See also [16U20](#)]

16P60 Chain conditions on annihilators and summands: Goldie-type conditions [See also [16U20](#)], Krull dimension (associative rings and algebras)

16P70 Chain conditions on other classes of submodules, ideals, subrings, etc.; coherence (associative rings and algebras)

16P90 Growth rate, Gelfand-Kirillov dimension

16P99 None of the above, but in this section

16Rxx Rings with polynomial identity

16R10 T -ideals, identities, varieties of associative rings and algebras

16R20 Semiprime p.i. rings, rings embeddable in matrices over commutative rings

16R30 Trace rings and invariant theory (associative rings and algebras)

16R40 Identities other than those of matrices over commutative rings

16R50 Other kinds of identities (generalized polynomial, rational, involution)

16R60 Functional identities (associative rings and algebras)

16R99 None of the above, but in this section

16Sxx Associative rings and algebras arising under various constructions

- 16S10** Associative rings determined by universal properties (free algebras, coproducts, adjunction of inverses, etc.)
- 16S15** Finite generation, finite presentability, normal forms (diamond lemma, term-rewriting)
- 16S20** Centralizing and normalizing extensions
- 16S30** Universal enveloping algebras of Lie algebras [See mainly [17B35](#)]
- 16S32** Rings of differential operators (associative algebraic aspects) [See also [13N10](#), [32C38](#)]
- 16S34** Group rings [See also [20C05](#), [20C07](#)], Laurent polynomial rings (associative algebraic aspects)
- 16S35** Twisted and skew group rings, crossed products
- 16S36** Ordinary and skew polynomial rings and semigroup rings [See also [20M25](#)]
- 16S37** Quadratic and Koszul algebras
- 16S38** Rings arising from noncommutative algebraic geometry [See also [14A22](#)]
- 16S40** Smash products of general Hopf actions [See also [16T05](#)]
- 16S50** Endomorphism rings; matrix rings [See also [15-XX](#)]
- 16S60** Associative rings of functions, subdirect products, sheaves of rings
- 16S70** Extensions of associative rings by ideals
- 16S80** Deformations of associative rings [See also [13D10](#), [14D15](#)]
- 16S85** Associative rings of fractions and localizations [See also [13B30](#)]
- 16S88** Leavitt path algebras
- 16S90** Torsion theories; radicals on module categories (associative algebraic aspects) [See also [13D30](#), [18E40](#)] {For radicals of rings, see [16Nxx](#)}
- 16S99** None of the above, but in this section

16Txx Hopf algebras, quantum groups and related topics

- 16T05** Hopf algebras and their applications [See also [16S40](#), [57T05](#)]
- 16T10** Bialgebras
- 16T15** Coalgebras and comodules; corings
- 16T20** Ring-theoretic aspects of quantum groups [See also [17B37](#), [20G42](#), [81R50](#)]
- 16T25** Yang-Baxter equations
- 16T30** Connections of associative rings and algebras with combinatorics
- 16T99** None of the above, but in this section

16Uxx Conditions on elements

- 16U10** Integral domains (associative rings and algebras)
- 16U20** Ore rings, multiplicative sets, Ore localization
- 16U30** Divisibility, noncommutative UFDs
- 16U40** Idempotent elements
- 16U50** Generalized inverses
- 16U60** Units, groups of units (associative rings and algebras)
- 16U70** Center, normalizer (invariant elements) (associative rings and algebras)
- 16U80** Generalizations of commutativity (associative rings and algebras)
- 16U99** None of the above, but in this section

16Wxx Associative rings and algebras with additional structure

- 16W10** Rings with involution; Lie, Jordan and other nonassociative structures [See also [17B60](#), [17C50](#), [46Kxx](#)]
- 16W20** Automorphisms and endomorphisms
- 16W22** Actions of groups and semigroups; invariant theory (associative rings and algebras)
- 16W25** Derivations, actions of Lie algebras
- 16W50** Graded rings and modules (associative rings and algebras)
- 16W55** “Super” (or “skew”) structure [See also [17A70](#), [17Bxx](#), [17C70](#)] {For exterior algebras, see [15A75](#); for Clifford algebras, see [11E88](#), [15A66](#)}
- 16W60** Valuations, completions, formal power series and related constructions (associative rings and algebras) [See also [13Jxx](#)]
- 16W70** Filtered associative rings; filtrational and graded techniques
- 16W80** Topological and ordered rings and modules [See also [06F25](#), [13Jxx](#)]
- 16W99** None of the above, but in this section

16Yxx Generalizations {For nonassociative rings, see [17-XX](#)}

- 16Y20** Hyperrings
- 16Y30** Near-rings [See also [12K05](#)]
- 16Y60** Semirings [See also [12K10](#)]
- 16Y80** Γ and fuzzy structures
- 16Y99** None of the above, but in this section

16Zxx Computational aspects of associative rings {For software etc., see [16-04](#)}

- 16Z05** Computational aspects of associative rings [See also [68W30](#)]
- 16Z10** Gröbner-Shirshov bases
- 16Z99** None of the above, but in this section

17-XX Nonassociative rings and algebras

17-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to nonassociative rings and algebras

17-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to nonassociative rings and algebras

17-02 Research exposition (monographs, survey articles) pertaining to nonassociative rings and algebras

17-03 History of nonassociative rings and algebras [Consider also classification numbers pertaining to Section [01](#)]

17-04 Software, source code, etc. for problems pertaining to nonassociative rings and algebras

17-06 Proceedings, conferences, collections, etc. pertaining to nonassociative rings and algebras

17-08 Computational methods for problems pertaining to nonassociative rings and algebras

17-11 Research data for problems pertaining to nonassociative rings and algebras

17Axx General nonassociative rings

17A01 General theory of nonassociative rings and algebras

17A05 Power-associative rings

17A15 Noncommutative Jordan algebras

17A20 Flexible algebras

17A30 Nonassociative algebras satisfying other identities

17A32 Leibniz algebras

17A35 Nonassociative division algebras

17A36 Automorphisms, derivations, other operators (nonassociative rings and algebras)

17A40 Ternary compositions

17A42 Other n -ary compositions ($n \geq 3$)

17A45 Quadratic algebras (but not quadratic Jordan algebras)

17A50 Free nonassociative algebras

17A60 Structure theory for nonassociative algebras

17A61 Gröbner-Shirshov bases in nonassociative algebras

17A65 Radical theory (nonassociative rings and algebras)

17A70 Superalgebras

17A75 Composition algebras

17A80 Valued algebras

17A99 None of the above, but in this section

17Bxx Lie algebras and Lie superalgebras {For Lie groups, see [22Exx](#)}

17B01 Identities, free Lie (super)algebras

17B05 Structure theory for Lie algebras and superalgebras

17B08 Coadjoint orbits; nilpotent varieties

17B10 Representations of Lie algebras and Lie superalgebras, algebraic theory (weights)

17B15 Representations of Lie algebras and Lie superalgebras, analytic theory

17B20 Simple, semisimple, reductive (super)algebras

17B22 Root systems

17B25 Exceptional (super)algebras

17B30 Solvable, nilpotent (super)algebras

17B35 Universal enveloping (super)algebras [See also [16S30](#)]

17B37 Quantum groups (quantized enveloping algebras) and related deformations [See also [16T20](#), [20G42](#), [81R50](#), [82B23](#)]

17B38 Yang-Baxter equations and Rota-Baxter operators

17B40 Automorphisms, derivations, other operators for Lie algebras and super algebras

17B45 Lie algebras of linear algebraic groups [See also [14Lxx](#) and [20Gxx](#)]

17B50 Modular Lie (super)algebras

17B55 Homological methods in Lie (super)algebras

17B56 Cohomology of Lie (super)algebras

17B60 Lie (super)algebras associated with other structures (associative, Jordan, etc.) [See also [16W10](#), [17C40](#), [17C50](#)]

17B61 Hom-Lie and related algebras

17B62 Lie bialgebras; Lie coalgebras

17B63 Poisson algebras

17B65 Infinite-dimensional Lie (super)algebras [See also [22E65](#)]

17B66 Lie algebras of vector fields and related (super) algebras

17B67 Kac-Moody (super)algebras; extended affine Lie algebras; toroidal Lie algebras

17B68 Virasoro and related algebras

17B69 Vertex operators; vertex operator algebras and related structures

17B70 Graded Lie (super)algebras

17B75 Color Lie (super)algebras

17B80 Applications of Lie algebras and superalgebras to integrable systems

17B81 Applications of Lie (super)algebras to physics, etc.

17B99 None of the above, but in this section

17Cxx Jordan algebras (algebras, triples and pairs)

- 17C05** Identities and free Jordan structures
- 17C10** Structure theory for Jordan algebras
- 17C17** Radicals in Jordan algebras
- 17C20** Simple, semisimple Jordan algebras
- 17C27** Idempotents, Peirce decompositions
- 17C30** Associated groups, automorphisms of Jordan algebras
- 17C36** Associated manifolds of Jordan algebras
- 17C37** Associated geometries of Jordan algebras
- 17C40** Exceptional Jordan structures
- 17C50** Jordan structures associated with other structures [See also [16W10](#)]
- 17C55** Finite-dimensional structures of Jordan algebras
- 17C60** Division algebras and Jordan algebras
- 17C65** Jordan structures on Banach spaces and algebras [See also [46H70](#), [46L70](#)]
- 17C70** Super structures
- 17C90** Applications of Jordan algebras to physics, etc.
- 17C99** None of the above, but in this section

17Dxx Other nonassociative rings and algebras

- 17D05** Alternative rings
- 17D10** Mal'tsev rings and algebras
- 17D15** Right alternative rings
- 17D20** (γ, δ) -rings, including $(1, -1)$ -rings
- 17D25** Lie-admissible algebras
- 17D30** (non-Lie) Hom algebras and topics
- 17D92** Genetic algebras
- 17D99** None of the above, but in this section

18-XX Category theory; homological algebra {For commutative rings, see [13Dxx](#); for associative rings, see [16Exx](#); for groups, see [20Jxx](#); for topological groups and related structures, see [57Txx](#); for algebraic topology, see also [55Nxx](#), [55Uxx](#)}

- 18-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to category theory
- 18-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to category theory

- 18-02 Research exposition (monographs, survey articles) pertaining to category theory
- 18-03 History of category theory [Consider also classification numbers pertaining to Section 01]
- 18-04 Software, source code, etc. for problems pertaining to category theory
- 18-06 Proceedings, conferences, collections, etc. pertaining to category theory
- 18-08 Computational methods for problems pertaining to category theory
- 18-11 Research data for problems pertaining to category theory

18Axx General theory of categories and functors

- 18A05 Definitions and generalizations in theory of categories
- 18A10 Graphs, diagram schemes, precategories
- 18A15 Foundations, relations to logic and deductive systems [See also 03-XX]
- 18A20 Epimorphisms, monomorphisms, special classes of morphisms, null morphisms
- 18A22 Special properties of functors (faithful, full, etc.)
- 18A23 Natural morphisms, dinatural morphisms
- 18A25 Functor categories, comma categories
- 18A30 Limits and colimits (products, sums, directed limits, pushouts, fiber products, equalizers, kernels, ends and coends, etc.)
- 18A32 Factorization systems, substructures, quotient structures, congruences, amalgams
- 18A35 Categories admitting limits (complete categories), functors preserving limits, completions
- 18A40 Adjoint functors (universal constructions, reflective subcategories, Kan extensions, etc.)
- 18A50 Graded categories (general) {For dg categories, see 18G35}
- 18A99 None of the above, but in this section

18Bxx Special categories

- 18B05 Categories of sets, characterizations [See also 03-XX]
- 18B10 Categories of spans/cospans, relations, or partial maps
- 18B15 Embedding theorems, universal categories [See also 18E20]
- 18B20 Categories of machines, automata [See also 03D05, 68Qxx]
- 18B25 Topoi [See also 03G30, 18F10]
- 18B35 Preorders, orders, domains and lattices (viewed as categories) [See also 06-XX]
- 18B40 Groupoids, semigroupoids, semigroups, groups (viewed as categories) [See also 20Axx, 20L05, 20Mxx]
- 18B50 Extensive, distributive, and adhesive categories
- 18B99 None of the above, but in this section

18Cxx Categories and theories

- 18C05 Equational categories [See also [03C05](#), [08C05](#)]
- 18C10 Theories (e.g., algebraic theories), structure, and semantics [See also [03G30](#)]
- 18C15 Monads (= standard construction, monad or triad), algebras for a triple, homology and derived functors for triples [See also [18Gxx](#)] {For functional programming, see also [68N18](#)}
- 18C20 Eilenberg-Moore and Kleisli constructions for monads
- 18C30 Sketches and generalizations
- 18C35 Accessible and locally presentable categories
- 18C40 Structured objects in a category (group objects, etc.)
- 18C50 Categorical semantics of formal languages [See also [68Q55](#), [68Q65](#)]
- 18C99 None of the above, but in this section

18Dxx Categorical structures

- 18D15 Closed categories (closed monoidal and Cartesian closed categories, etc.)
- 18D20 Enriched categories (over closed or monoidal categories)
- 18D25 Actions of a monoidal category, tensorial strength {For functional programming, see also [68N18](#)}
- 18D30 Fibered categories
- 18D40 Internal categories and groupoids {For double categories, see [18N10](#); for topological groupoids, see [22A22](#); for Lie groupoids, see [58H05](#)}
- 18D60 Profunctors (= correspondences, distributors, modules)
- 18D65 Proarrow equipments, Yoneda structures, KZ doctrines (lax idempotent monads)
- 18D70 Formal category theory
- 18D99 None of the above, but in this section

18Exx Categorical algebra

- 18E05 Preadditive, additive categories
- 18E08 Regular categories, Barr-exact categories
- 18E10 Abelian categories, Grothendieck categories
- 18E13 Protomodular categories, semi-abelian categories, Mal'tsev categories [See also [08B05](#) and [18B10](#)]
- 18E20 Categorical embedding theorems [See also [18B15](#)]
- 18E35 Localization of categories, calculus of fractions {For homotopical aspects, see also [18N45](#), [55P60](#)}
- 18E40 Torsion theories, radicals [See also [13D30](#), [16S90](#)]
- 18E45 Definable subcategories and connections with model theory [See also [13C60](#)]
- 18E50 Categorical Galois theory
- 18E99 None of the above, but in this section

18Fxx Categories in geometry and topology

18F05 Local categories and functors

18F10 Grothendieck topologies and Grothendieck topoi [See also [14F20](#), [18B25](#)]

18F15 Abstract manifolds and fiber bundles (category-theoretic aspects) [See also [55Rxx](#), [57Pxx](#)]

18F20 Presheaves and sheaves, stacks, descent conditions (category-theoretic aspects) [See also [14F06](#), [14F07](#), [32C35](#), [32L10](#), [54B40](#), [55N30](#)]

18F25 Algebraic K -theory and L -theory (category-theoretic aspects) [See also [11Exx](#), [11R70](#), [11S70](#), [12-XX](#), [13D15](#), [14Cxx](#), [16E20](#), [19-XX](#), [46L80](#), [57R65](#), [57R67](#)]

18F30 Grothendieck groups (category-theoretic aspects) [See also [13D15](#), [16E20](#), [19Axx](#)]

18F40 Synthetic differential geometry, tangent categories, differential categories

18F50 Goodwillie calculus and functor calculus

18F60 Categories of topological spaces and continuous mappings [See also [54-XX](#)]

18F70 Frames and locales, pointfree topology, Stone duality [See also [06D22](#), [18B35](#)]

18F75 Quantaes [See also [06F07](#), [18B35](#)]

18F99 None of the above, but in this section

18Gxx Homological algebra in category theory, derived categories and functors [See also [13Dxx](#), [16Exx](#), [20Jxx](#), [55Nxx](#), [55Uxx](#), [57Txx](#)]

18G05 Projectives and injectives (category-theoretic aspects) [See also [13C10](#), [13C11](#), [16D40](#), [16D50](#)]

18G10 Resolutions; derived functors (category-theoretic aspects) [See also [13D02](#), [16E05](#), [18Gxx](#)]

18G15 Ext and Tor, generalizations, Künneth formula (category-theoretic aspects) [See also [55U25](#)]

18G20 Homological dimension (category-theoretic aspects) [See also [13D05](#), [16E10](#)]

18G25 Relative homological algebra, projective classes (category-theoretic aspects)

18G31 Simplicial modules and Dold-Kan correspondence

18G35 Chain complexes (category-theoretic aspects), dg categories [See also [14F07](#), [18G80](#), [55U15](#)]

18G40 Spectral sequences, hypercohomology [See also [55Txx](#)]

18G45 2-groups, crossed modules, crossed complexes

18G50 Nonabelian homological algebra (category-theoretic aspects)

18G65 Stable module categories [See also [20C20](#)]

18G70 A_∞ -categories, relations with homological mirror symmetry [See also [14F07](#), [14J33](#), [53D37](#)]

18G80 Derived categories, triangulated categories

18G85 Graph complexes and graph homology {For relations with deformation quantization, see [53D55](#)}

18G90 Other (co)homology theories (category-theoretic aspects) [See also [19D55](#), [46L80](#), [58J20](#), [58J22](#)]

18G99 None of the above, but in this section

18Mxx Monoidal categories and operads

- 18M05 Monoidal categories, symmetric monoidal categories [See also [19D23](#)]
- 18M10 Traced monoidal categories, compact closed categories, star-autonomous categories
- 18M15 Braided monoidal categories and ribbon categories {For applications to knot theory, see also [57Kxx](#); for applications to quantum groups, see also [16T20](#), [17B37](#), [81R50](#)}
- 18M20 Fusion categories, modular tensor categories, modular functors {For applications to topological quantum field theories, see also [57R56](#); for applications to conformal field theories, see also [81T40](#)}
- 18M25 Tannakian categories {For applications to motives, see also [14C15](#), [19E15](#)}
- 18M30 String diagrams and graphical calculi
- 18M35 Categories of networks and processes, compositionality
- 18M40 Dagger categories, categorical quantum mechanics [See also [81P68](#)]
- 18M45 Categorical aspects of linear logic [See also [03B47](#)]
- 18M50 Bimonoidal, skew-monoidal, duoidal categories
- 18M60 Operads (general)
- 18M65 Non-symmetric operads, multicategories, generalized multicategories
- 18M70 Algebraic operads, cooperads, and Koszul duality
- 18M75 Topological and simplicial operads [See also [18N60](#)]
- 18M80 Species, Hopf monoids, operads in combinatorics
- 18M85 Polycategories/dioperads, properads, PROPs, cyclic operads, modular operads
- 18M90 Globular operads
- 18M99 None of the above, but in this section

18Nxx Higher categories and homotopical algebra

- 18N10 2-categories, bicategories, double categories
- 18N15 2-dimensional monad theory [See also [18C15](#)]
- 18N20 Tricategories, weak n -categories, coherence, semi-strictification
- 18N25 Categorification
- 18N30 Strict omega-categories, computads, polygraphs
- 18N40 Homotopical algebra, Quillen model categories, derivators [See also [55U35](#)]
- 18N45 Categories of fibrations, relations to K -theory, relations to type theory
- 18N50 Simplicial sets, simplicial objects [See also [55U10](#)]
- 18N55 Localizations (e.g., simplicial localization, Bousfield localization) [See also [18E35](#), [55P60](#)]
- 18N60 $(\infty, 1)$ -categories (quasi-categories, Segal spaces, etc.); ∞ -topoi, stable ∞ -categories [See also [55U35](#), [55U40](#)]
- 18N65 (∞, n) -categories and (∞, ∞) -categories
- 18N70 ∞ -operads and higher algebra [See also [18M75](#)]
- 18N99 None of the above, but in this section

19-XX K -theory [See also [16E20](#), [18F25](#)]

19-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to K -theory

19-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to K -theory

19-02 Research exposition (monographs, survey articles) pertaining to K -theory

19-03 History of K -theory [Consider also classification numbers pertaining to Section [01](#)]

19-04 Software, source code, etc. for problems pertaining to K -theory

19-06 Proceedings, conferences, collections, etc. pertaining to K -theory

19-08 Computational methods for problems pertaining to K -theory

19-11 Research data for problems pertaining to K -theory

19Axx Grothendieck groups and K_0 [See also [13D15](#), [18F30](#)]

19A13 Stability for projective modules [See also [13C10](#)]

19A15 Efficient generation of modules

19A22 Frobenius induction, Burnside and representation rings

19A31 K_0 of group rings and orders

19A49 K_0 of other rings

19A99 None of the above, but in this section

19Bxx Whitehead groups and K_1

19B10 Stable range conditions

19B14 Stability for linear groups

19B28 K_1 of group rings and orders [See also [57Q10](#)]

19B37 Congruence subgroup problems [See also [20H05](#)]

19B99 None of the above, but in this section

19Cxx Steinberg groups and K_2

19C09 Central extensions and Schur multipliers

19C20 Symbols, presentations and stability of K_2

19C30 K_2 and the Brauer group

19C40 Excision for K_2

19C99 None of the above, but in this section

19Dxx Higher algebraic K -theory

19D06 Q - and plus-constructions

19D10 Algebraic K -theory of spaces

19D23 Symmetric monoidal categories [See also [18M05](#)]

19D25 Karoubi-Villamayor-Gersten K -theory

19D35 Negative K -theory, NK and Nil

19D45 Higher symbols, Milnor K -theory

19D50 Computations of higher K -theory of rings [See also [13D15](#), [16E20](#)]

19D55 K -theory and homology; cyclic homology and cohomology [See also [18G90](#)]

19D99 None of the above, but in this section

19Exx K -theory in geometry

19E08 K -theory of schemes [See also [14C35](#)]

19E15 Algebraic cycles and motivic cohomology (K -theoretic aspects) [See also [14C25](#), [14C35](#), [14F42](#)]

19E20 Relations of K -theory with cohomology theories [See also [14Fxx](#)]

19E99 None of the above, but in this section

19Fxx K -theory in number theory [See also [11R70](#), [11S70](#)]

19F05 Generalized class field theory (K -theoretic aspects) [See also [11G45](#)]

19F15 Symbols and arithmetic (K -theoretic aspects) [See also [11R37](#)]

19F27 Étale cohomology, higher regulators, zeta and L -functions (K -theoretic aspects) [See also [11G40](#), [11R42](#), [11S40](#), [14F20](#), [14G10](#)]

19F99 None of the above, but in this section

19Gxx K -theory of forms [See also [11Exx](#)]

19G05 Stability for quadratic modules

19G12 Witt groups of rings [See also [11E81](#)]

19G24 L -theory of group rings [See also [11E81](#)]

19G38 Hermitian K -theory, relations with K -theory of rings

19G99 None of the above, but in this section

19Jxx Obstructions from topology

19J05 Finiteness and other obstructions in K_0

19J10 Whitehead (and related) torsion

19J25 Surgery obstructions (K -theoretic aspects) [See also [57R67](#)]

19J35 Obstructions to group actions (K -theoretic aspects)

19J99 None of the above, but in this section

19Kxx *K*-theory and operator algebras [See mainly [46L80](#), and also [46M20](#)]

19K14 K_0 as an ordered group, traces

19K33 Ext and *K*-homology [See also [55N22](#)]

19K35 Kasparov theory (*KK*-theory) [See also [58J22](#)]

19K56 Index theory [See also [58J20](#), [58J22](#)]

19K99 None of the above, but in this section

19Lxx Topological *K*-theory [See also [55N15](#), [55R50](#), [55S25](#)]

19L10 Riemann-Roch theorems, Chern characters

19L20 *J*-homomorphism, Adams operations [See also [55Q50](#)]

19L41 Connective *K*-theory, cobordism [See also [55N22](#)]

19L47 Equivariant *K*-theory [See also [55N91](#), [55P91](#), [55Q91](#), [55R91](#), [55S91](#)]

19L50 Twisted *K*-theory; differential *K*-theory

19L64 Geometric applications of topological *K*-theory

19L99 None of the above, but in this section

19Mxx Miscellaneous applications of *K*-theory

19M05 Miscellaneous applications of *K*-theory

19M99 None of the above, but in this section

20-XX Group theory and generalizations

20-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to group theory

20-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to group theory

20-02 Research exposition (monographs, survey articles) pertaining to group theory

20-03 History of group theory [Consider also classification numbers pertaining to [Section 01](#)]

20-04 Software, source code, etc. for problems pertaining to group theory

20-06 Proceedings, conferences, collections, etc. pertaining to group theory

20-08 Computational methods for problems pertaining to group theory

20-11 Research data for problems pertaining to group theory

20Axx Foundations

20A05 Axiomatics and elementary properties of groups

20A10 Metamathematical considerations in group theory {For word problems, see [20F10](#)}

20A15 Applications of logic to group theory

20A99 None of the above, but in this section

20Bxx Permutation groups

20B05 General theory for finite permutation groups

20B07 General theory for infinite permutation groups

20B10 Characterization theorems for permutation groups

20B15 Primitive groups

20B20 Multiply transitive finite groups

20B22 Multiply transitive infinite groups

20B25 Finite automorphism groups of algebraic, geometric, or combinatorial structures [See also [05Bxx](#), [12F10](#), [20G40](#), [20H30](#), [51-XX](#)]

20B27 Infinite automorphism groups [See also [12F10](#)]

20B30 Symmetric groups

20B35 Subgroups of symmetric groups

20B99 None of the above, but in this section

20Cxx Representation theory of groups {For representation rings and Burnside rings, see also [19A22](#)}

20C05 Group rings of finite groups and their modules (group-theoretic aspects) [See also [16S34](#)]

20C07 Group rings of infinite groups and their modules (group-theoretic aspects) [See also [16S34](#)]

20C08 Hecke algebras and their representations

20C10 Integral representations of finite groups

20C11 p -adic representations of finite groups

20C12 Integral representations of infinite groups

20C15 Ordinary representations and characters

20C20 Modular representations and characters

20C25 Projective representations and multipliers

20C30 Representations of finite symmetric groups

20C32 Representations of infinite symmetric groups

20C33 Representations of finite groups of Lie type

20C34 Representations of sporadic groups

20C35 Applications of group representations to physics and other areas of science

20C99 None of the above, but in this section

20Dxx Abstract finite groups

20D05 Finite simple groups and their classification

20D06 Simple groups: alternating groups and groups of Lie type [See also [20Gxx](#)]

20D08 Simple groups: sporadic groups

20D10 Finite solvable groups, theory of formations, Schunck classes, Fitting classes, π -length, ranks [See also [20F17](#)]

20D15 Finite nilpotent groups, p -groups

20D20 Sylow subgroups, Sylow properties, π -groups, π -structure

20D25 Special subgroups (Fratini, Fitting, etc.)

20D30 Series and lattices of subgroups

20D35 Subnormal subgroups of abstract finite groups

20D40 Products of subgroups of abstract finite groups

20D45 Automorphisms of abstract finite groups

20D60 Arithmetic and combinatorial problems involving abstract finite groups

20D99 None of the above, but in this section

20Exx Structure and classification of infinite or finite groups

20E05 Free nonabelian groups

20E06 Free products of groups, free products with amalgamation, Higman-Neumann-Neumann extensions, and generalizations

20E07 Subgroup theorems; subgroup growth

20E08 Groups acting on trees [See also [20F65](#)]

20E10 Quasivarieties and varieties of groups

20E15 Chains and lattices of subgroups, subnormal subgroups [See also [20F22](#)]

20E18 Limits, profinite groups

20E22 Extensions, wreath products, and other compositions of groups [See also [20J05](#)]

20E25 Local properties of groups

20E26 Residual properties and generalizations; residually finite groups

20E28 Maximal subgroups

20E32 Simple groups [See also [20D05](#)]

20E34 General structure theorems for groups

20E36 Automorphisms of infinite groups [For automorphisms of finite groups, see [20D45](#)]

20E42 Groups with a BN -pair; buildings [See also [51E24](#)]

20E45 Conjugacy classes for groups

20E99 None of the above, but in this section

20Fxx Special aspects of infinite or finite groups

20F05 Generators, relations, and presentations of groups

20F06 Cancellation theory of groups; application of van Kampen diagrams [See also [57M05](#)]

20F10 Word problems, other decision problems, connections with logic and automata (group-theoretic aspects) [See also [03B25](#), [03D05](#), [03D40](#), [06B25](#), [08A50](#), [20M05](#), [68Q70](#)]

20F11 Groups of finite Morley rank [See also [03C45](#), [03C60](#)]

20F12 Commutator calculus

20F14 Derived series, central series, and generalizations for groups

20F16 Solvable groups, supersolvable groups [See also [20D10](#)]

20F17 Formations of groups, Fitting classes [See also [20D10](#)]

20F18 Nilpotent groups [See also [20D15](#)]

20F19 Generalizations of solvable and nilpotent groups

20F22 Other classes of groups defined by subgroup chains

20F24 FC-groups and their generalizations

20F28 Automorphism groups of groups [See also [20E36](#)]

20F29 Representations of groups as automorphism groups of algebraic systems

20F34 Fundamental groups and their automorphisms (group-theoretic aspects) [See also [57M05](#), [57Sxx](#)]

20F36 Braid groups; Artin groups

20F38 Other groups related to topology or analysis

20F40 Associated Lie structures for groups

20F45 Engel conditions

20F50 Periodic groups; locally finite groups

20F55 Reflection and Coxeter groups (group-theoretic aspects) [See also [22E40](#), [51F15](#)]

20F60 Ordered groups (group-theoretic aspects) [See mainly [06F15](#)]

20F65 Geometric group theory [See also [05C25](#), [20E08](#), [57Mxx](#)]

20F67 Hyperbolic groups and nonpositively curved groups

20F69 Asymptotic properties of groups

20F70 Algebraic geometry over groups; equations over groups

20F99 None of the above, but in this section

20Gxx Linear algebraic groups and related topics {For arithmetic theory, see [11E57](#), [11H56](#); for geometric theory, see [14Lxx](#), [22Exx](#); for other methods in representation theory, see [15A30](#), [22E45](#), [22E46](#), [22E47](#), [22E50](#), [22E55](#)}

20G05 Representation theory for linear algebraic groups

20G07 Structure theory for linear algebraic groups

20G10 Cohomology theory for linear algebraic groups

20G15 Linear algebraic groups over arbitrary fields

20G20 Linear algebraic groups over the reals, the complexes, the quaternions

20G25 Linear algebraic groups over local fields and their integers

20G30 Linear algebraic groups over global fields and their integers

20G35 Linear algebraic groups over adèles and other rings and schemes

20G40 Linear algebraic groups over finite fields

20G41 Exceptional groups

20G42 Quantum groups (quantized function algebras) and their representations [See also [16T20](#), [17B37](#), [81R50](#)]

20G43 Schur and q -Schur algebras

20G44 Kac-Moody groups

20G45 Applications of linear algebraic groups to the sciences

20G99 None of the above, but in this section

20Hxx Other groups of matrices [See also [15A30](#)]

20H05 Unimodular groups, congruence subgroups (group-theoretic aspects) [See also [11F06](#), [19B37](#), [22E40](#), [51F20](#)]

20H10 Fuchsian groups and their generalizations (group-theoretic aspects) [See also [11F06](#), [22E40](#), [30F35](#), [32Nxx](#)]

20H15 Other geometric groups, including crystallographic groups [See also [51-XX](#), especially [51F15](#), and [82D25](#)]

20H20 Other matrix groups over fields

20H25 Other matrix groups over rings

20H30 Other matrix groups over finite fields

20H99 None of the above, but in this section

20Jxx Connections of group theory with homological algebra and category theory

20J05 Homological methods in group theory

20J06 Cohomology of groups

20J15 Category of groups

20J99 None of the above, but in this section

20Kxx Abelian groups

- 20K01** Finite abelian groups {For sumsets, see [11B13](#), [11P70](#)}
- 20K10** Torsion groups, primary groups and generalized primary groups
- 20K15** Torsion-free groups, finite rank
- 20K20** Torsion-free groups, infinite rank
- 20K21** Mixed groups
- 20K25** Direct sums, direct products, etc. for abelian groups
- 20K27** Subgroups of abelian groups
- 20K30** Automorphisms, homomorphisms, endomorphisms, etc. for abelian groups
- 20K35** Extensions of abelian groups
- 20K40** Homological and categorical methods for abelian groups
- 20K45** Topological methods for abelian groups [See also [22A05](#), [22B05](#)]
- 20K99** None of the above, but in this section

20Lxx Groupoids (i.e. small categories in which all morphisms are isomorphisms) {For sets with a single binary operation, see [20N02](#); for topological groupoids, see [22A22](#), [58H05](#)}

- 20L05** Groupoids (i.e. small categories in which all morphisms are isomorphisms) {For sets with a single binary operation, see [20N02](#); for topological groupoids, see [22A22](#), [58H05](#)}
- 20L99** None of the above, but in this section

20Mxx Semigroups

- 20M05** Free semigroups, generators and relations, word problems [See also [03D40](#), [08A50](#), [20F10](#)]
- 20M07** Varieties and pseudovarieties of semigroups
- 20M10** General structure theory for semigroups
- 20M11** Radical theory for semigroups
- 20M12** Ideal theory for semigroups
- 20M13** Arithmetic theory of semigroups
- 20M14** Commutative semigroups
- 20M15** Mappings of semigroups
- 20M17** Regular semigroups
- 20M18** Inverse semigroups
- 20M19** Orthodox semigroups
- 20M20** Semigroups of transformations, relations, partitions, etc. [See also [47D03](#), [47H20](#), [54H15](#)]
- 20M25** Semigroup rings, multiplicative semigroups of rings [See also [16S36](#), [16Y60](#)]

20M30 Representation of semigroups; actions of semigroups on sets

20M32 Algebraic monoids

20M35 Semigroups in automata theory, linguistics, etc. [See also [03D05](#), [68Q70](#), [68T50](#)]

20M50 Connections of semigroups with homological algebra and category theory

20M75 Generalizations of semigroups

20M99 None of the above, but in this section

20Nxx Other generalizations of groups

20N02 Sets with a single binary operation (groupoids) {For groupoids in connection with category theory, see [20L05](#); for topological groupoids, see [22A22](#), [58H05](#)}

20N05 Loops, quasigroups [See also [05Bxx](#)]

20N10 Ternary systems (heaps, semiheaps, heapoids, etc.)

20N15 n -ary systems ($n \geq 3$)

20N20 Hypergroups

20N25 Fuzzy groups [See also [03E72](#)]

20N99 None of the above, but in this section

20Pxx Probabilistic methods in group theory [See also [60Bxx](#)]

20P05 Probabilistic methods in group theory [See also [60Bxx](#)]

20P99 None of the above, but in this section

22-XX Topological groups, Lie groups {For transformation groups, see [54H15](#), [57Sxx](#), [58-XX](#); for abstract harmonic analysis, see [43-XX](#)}

22-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to topological groups

22-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to topological groups

22-02 Research exposition (monographs, survey articles) pertaining to topological groups

22-03 History of topological groups [Consider also classification numbers pertaining to [Section 01](#)]

22-04 Software, source code, etc. for problems pertaining to topological groups

22-06 Proceedings, conferences, collections, etc. pertaining to topological groups

22-08 Computational methods for problems pertaining to topological groups

22-11 Research data for problems pertaining to topological groups

22Axx Topological and differentiable algebraic systems {For topological rings and fields, see [12Jxx](#), [13Jxx](#), [16W80](#)}

22A05 Structure of general topological groups

22A10 Analysis on general topological groups

22A15 Structure of topological semigroups

22A20 Analysis on topological semigroups

22A22 Topological groupoids (including differentiable and Lie groupoids) [See also [58H05](#)]

22A25 Representations of general topological groups and semigroups

22A26 Topological semilattices, lattices and applications [See also [06B30](#), [06B35](#), [06F30](#)]

22A30 Other topological algebraic systems and their representations

22A99 None of the above, but in this section

22Bxx Locally compact abelian groups (LCA groups)

22B05 General properties and structure of LCA groups

22B10 Structure of group algebras of LCA groups

22B99 None of the above, but in this section

22Cxx Compact groups

22C05 Compact groups

22C99 None of the above, but in this section

22Dxx Locally compact groups and their algebras

22D05 General properties and structure of locally compact groups

22D10 Unitary representations of locally compact groups

22D12 Other representations of locally compact groups

22D15 Group algebras of locally compact groups

22D20 Representations of group algebras

22D25 C^* -algebras and W^* -algebras in relation to group representations [See also [46Lxx](#)]

22D30 Induced representations for locally compact groups

22D35 Duality theorems for locally compact groups

22D40 Ergodic theory on groups [See also [28Dxx](#)]

22D45 Automorphism groups of locally compact groups

22D50 Rigidity in locally compact groups

22D55 Kazhdan's property (T), the Haagerup property, and generalizations

22D99 None of the above, but in this section

22Exx Lie groups {For the topology of Lie groups and homogeneous spaces, see [57Sxx](#), [57Txx](#); for analysis thereon, see [43A80](#), [43A85](#), [43A90](#)}

22E05 Local Lie groups [See also [34-XX](#), [35-XX](#), [58H05](#)]

22E10 General properties and structure of complex Lie groups [See also [32M05](#)]

22E15 General properties and structure of real Lie groups

22E20 General properties and structure of other Lie groups

22E25 Nilpotent and solvable Lie groups

22E27 Representations of nilpotent and solvable Lie groups (special orbital integrals, non-type I representations, etc.)

22E30 Analysis on real and complex Lie groups [See also [33C80](#), [43-XX](#)]

22E35 Analysis on p -adic Lie groups

22E40 Discrete subgroups of Lie groups [See also [20Hxx](#), [32Nxx](#)]

22E41 Continuous cohomology of Lie groups [See also [57R32](#), [57Txx](#), [58H10](#)]

22E43 Structure and representation of the Lorentz group

22E45 Representations of Lie and linear algebraic groups over real fields: analytic methods {For the purely algebraic theory, see [20G05](#)}

22E46 Semisimple Lie groups and their representations

22E47 Representations of Lie and real algebraic groups: algebraic methods (Verma modules, etc.) [See also [17B10](#)]

22E50 Representations of Lie and linear algebraic groups over local fields [See also [20G05](#)]

22E55 Representations of Lie and linear algebraic groups over global fields and adèle rings [See also [20G05](#)]

22E57 Geometric Langlands program: representation-theoretic aspects [See also [14D24](#)]

22E60 Lie algebras of Lie groups {For the algebraic theory of Lie algebras, see [17Bxx](#)}

22E65 Infinite-dimensional Lie groups and their Lie algebras: general properties [See also [17B65](#), [58B25](#), [58D05](#), [58H05](#)]

22E66 Analysis on and representations of infinite-dimensional Lie groups

22E67 Loop groups and related constructions, group-theoretic treatment [See also [58D05](#)]

22E70 Applications of Lie groups to the sciences; explicit representations [See also [81R05](#), [81R10](#)]

22E99 None of the above, but in this section

22Fxx Noncompact transformation groups

22F05 General theory of group and pseudogroup actions {For topological properties of spaces with an action, see [57S20](#)}

22F10 Measurable group actions [See also [22D40](#), [28Dxx](#), [37Axx](#)]

22F30 Homogeneous spaces {For general actions on manifolds or preserving geometrical structures, see [57M60](#), [57Sxx](#); for discrete subgroups of Lie groups, see especially [22E40](#)}

22F50 Groups as automorphisms of other structures

22F99 None of the above, but in this section

26-XX Real functions [See also [54C30](#)]

26-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to real functions

26-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to real functions

26-02 Research exposition (monographs, survey articles) pertaining to real functions

26-03 History of real functions [Consider also classification numbers pertaining to [Section 01](#)]

26-04 Software, source code, etc. for problems pertaining to real functions

26-06 Proceedings, conferences, collections, etc. pertaining to real functions

26-08 Computational methods for problems pertaining to real functions

26-11 Research data for problems pertaining to real functions

26Axx Functions of one variable

26A03 Foundations: limits and generalizations, elementary topology of the line

26A06 One-variable calculus

26A09 Elementary functions

26A12 Rate of growth of functions, orders of infinity, slowly varying functions [See also [26A48](#)]

26A15 Continuity and related questions (modulus of continuity, semicontinuity, discontinuities, etc.) for real functions in one variable {For properties determined by Fourier coefficients, see [42A16](#); for those determined by approximation properties, see [41A25](#), [41A27](#)}

26A16 Lipschitz (Hölder) classes

26A18 Iteration of real functions in one variable [See also [37Bxx](#), [37Cxx](#), [37Exx](#), [39B12](#), [47H10](#), [54H25](#)]

26A21 Classification of real functions; Baire classification of sets and functions [See also [03E15](#), [28A05](#), [54C50](#), [54H05](#)]

26A24 Differentiation (real functions of one variable): general theory, generalized derivatives, mean value theorems [See also [28A15](#)]

26A27 Nondifferentiability (nondifferentiable functions, points of nondifferentiability), discontinuous derivatives

26A30 Singular functions, Cantor functions, functions with other special properties

26A33 Fractional derivatives and integrals

26A36 Antidifferentiation

26A39 Denjoy and Perron integrals, other special integrals

26A42 Integrals of Riemann, Stieltjes and Lebesgue type [See also [28-XX](#)]

26A45 Functions of bounded variation, generalizations

26A46 Absolutely continuous real functions in one variable

26A48 Monotonic functions, generalizations

26A51 Convexity of real functions in one variable, generalizations

26A99 None of the above, but in this section

26Bxx Functions of several variables

26B05 Continuity and differentiation questions

26B10 Implicit function theorems, Jacobians, transformations with several variables

26B12 Calculus of vector functions

26B15 Integration of real functions of several variables: length, area, volume [See also [28A75](#), [51M25](#)]

26B20 Integral formulas of real functions of several variables (Stokes, Gauss, Green, etc.)

26B25 Convexity of real functions of several variables, generalizations

26B30 Absolutely continuous real functions of several variables, functions of bounded variation

26B35 Special properties of functions of several variables, Hölder conditions, etc.

26B40 Representation and superposition of functions

26B99 None of the above, but in this section

26Cxx Polynomials, rational functions in real analysis

26C05 Real polynomials: analytic properties, etc. [See also [12Dxx](#), [12Exx](#)]

26C10 Real polynomials: location of zeros [See also [12D10](#), [30C15](#), [65H05](#)]

26C15 Real rational functions [See also [14Pxx](#)]

26C99 None of the above, but in this section

26Dxx Inequalities in real analysis {For maximal function inequalities, see [42B25](#); for functional inequalities, see [39B72](#); for probabilistic inequalities, see [60E15](#)}

26D05 Inequalities for trigonometric functions and polynomials

26D07 Inequalities involving other types of functions

26D10 Inequalities involving derivatives and differential and integral operators

26D15 Inequalities for sums, series and integrals

26D20 Other analytical inequalities

26D99 None of the above, but in this section

26Exx Miscellaneous topics in real functions [See also [58Cxx](#)]

26E05 Real-analytic functions [See also [32B05](#), [32C05](#)]

26E10 C^∞ -functions, quasi-analytic functions [See also [58C25](#)]

26E15 Calculus of functions on infinite-dimensional spaces [See also [46G05](#), [58Cxx](#)]

26E20 Calculus of functions taking values in infinite-dimensional spaces [See also [46E40](#), [46G10](#), [58Cxx](#)]

26E25 Set-valued functions [See also [28B20](#), [49J53](#), [54C60](#)] {For nonsmooth analysis, see [49J52](#), [58Cxx](#), [90Cxx](#)}

26E30 Non-Archimedean analysis [See also [12J25](#)]

26E35 Nonstandard analysis [See also [03H05](#), [28E05](#), [54J05](#)]

- 26E40** Constructive real analysis [See also [03F60](#)]
- 26E50** Fuzzy real analysis [See also [03E72](#), [28E10](#)]
- 26E60** Means [See also [47A64](#)]
- 26E70** Real analysis on time scales or measure chains {For dynamic equations on time scales or measure chains, see [34N05](#)}
- 26E99** None of the above, but in this section

28-XX Measure and integration {For analysis on manifolds, see [58-XX](#)}

- 28-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to measure and integration
- 28-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to measure and integration
- 28-02** Research exposition (monographs, survey articles) pertaining to measure and integration
- 28-03** History of measure and integration [Consider also classification numbers pertaining to Section [01](#)]
- 28-04** Software, source code, etc. for problems pertaining to measure and integration
- 28-06** Proceedings, conferences, collections, etc. pertaining to measure and integration
- 28-08** Computational methods for problems pertaining to measure and integration
- 28-11** Research data for problems pertaining to measure and integration

28Axx Classical measure theory

- 28A05** Classes of sets (Borel fields, σ -rings, etc.), measurable sets, Suslin sets, analytic sets [See also [03E15](#), [26A21](#), [54H05](#)]
- 28A10** Real- or complex-valued set functions
- 28A12** Contents, measures, outer measures, capacities
- 28A15** Abstract differentiation theory, differentiation of set functions [See also [26A24](#)]
- 28A20** Measurable and nonmeasurable functions, sequences of measurable functions, modes of convergence
- 28A25** Integration with respect to measures and other set functions
- 28A33** Spaces of measures, convergence of measures [See also [46E27](#), [60Bxx](#)]
- 28A35** Measures and integrals in product spaces
- 28A50** Integration and disintegration of measures
- 28A51** Lifting theory [See also [46G15](#)]
- 28A60** Measures on Boolean rings, measure algebras [See also [54H10](#)]
- 28A75** Length, area, volume, other geometric measure theory [See also [26B15](#), [49Q15](#)]
- 28A78** Hausdorff and packing measures
- 28A80** Fractals [See also [37Fxx](#)]
- 28A99** None of the above, but in this section

28Bxx Set functions, measures and integrals with values in abstract spaces

28B05 Vector-valued set functions, measures and integrals [See also [46G10](#)]

28B10 Group- or semigroup-valued set functions, measures and integrals

28B15 Set functions, measures and integrals with values in ordered spaces

28B20 Set-valued set functions and measures; integration of set-valued functions; measurable selections [See also [26E25](#), [54C60](#), [54C65](#), [91B14](#)]

28B99 None of the above, but in this section

28Cxx Set functions and measures on spaces with additional structure [See also [46G12](#), [58C35](#), [58D20](#)]

28C05 Integration theory via linear functionals (Radon measures, Daniell integrals, etc.), representing set functions and measures

28C10 Set functions and measures on topological groups or semigroups, Haar measures, invariant measures [See also [22Axx](#), [43A05](#)]

28C15 Set functions and measures on topological spaces (regularity of measures, etc.)

28C20 Set functions and measures and integrals in infinite-dimensional spaces (Wiener measure, Gaussian measure, etc.) [See also [46G12](#), [58C35](#), [58D20](#), [60B11](#)]

28C99 None of the above, but in this section

28Dxx Measure-theoretic ergodic theory [See also [11K50](#), [11K55](#), [22D40](#), [37Axx](#), [47A35](#), [60Fxx](#), [60G10](#)]

28D05 Measure-preserving transformations {For measure-preserving transformations and dynamical systems, see [37A05](#)}

28D10 One-parameter continuous families of measure-preserving transformations {For dynamical systems aspect, see [37A10](#)}

28D15 General groups of measure-preserving transformations {For dynamical systems aspects, see [37A15](#)}

28D20 Entropy and other invariants

28D99 None of the above, but in this section

28Exx Miscellaneous topics in measure theory

28E05 Nonstandard measure theory [See also [03H05](#), [26E35](#)]

28E10 Fuzzy measure theory [See also [03E72](#), [26E50](#), [94D05](#)]

28E15 Other connections with logic and set theory

28E99 None of the above, but in this section

30-XX Functions of a complex variable

30-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to functions of a complex variable

30-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to functions of a complex variable

30-02 Research exposition (monographs, survey articles) pertaining to functions of a complex variable

30-03 History of functions of a complex variable [Consider also classification numbers pertaining to Section [01](#)]

30-04 Software, source code, etc. for problems pertaining to functions of a complex variable

30-06 Proceedings, conferences, collections, etc. pertaining to functions of a complex variable

30-08 Computational methods for problems pertaining to functions of a complex variable [See also [65Exx](#)]

30-11 Research data for problems pertaining to functions of a complex variable

30Axx General properties of functions of one complex variable

30A05 Monogenic and polygenic functions of one complex variable

30A10 Inequalities in the complex plane

30A99 None of the above, but in this section

30Bxx Series expansions of functions of one complex variable

30B10 Power series (including lacunary series) in one complex variable

30B20 Random power series in one complex variable

30B30 Boundary behavior of power series in one complex variable; over-convergence

30B40 Analytic continuation of functions of one complex variable

30B50 Dirichlet series, exponential series and other series in one complex variable [See also [11M41](#), [42-XX](#)]

30B60 Completeness problems, closure of a system of functions of one complex variable

30B70 Continued fractions; complex-analytic aspects [See also [11A55](#), [40A15](#)]

30B99 None of the above, but in this section

30Cxx Geometric function theory

30C10 Polynomials and rational functions of one complex variable

30C15 Zeros of polynomials, rational functions, and other analytic functions of one complex variable (e.g., zeros of functions with bounded Dirichlet integral) {For algebraic theory, see [12D10](#); for real methods, see [26C10](#)}

30C20 Conformal mappings of special domains

30C25 Covering theorems in conformal mapping theory

30C30 Schwarz-Christoffel-type mappings [See also [65E10](#)]

30C35 General theory of conformal mappings

30C40 Kernel functions in one complex variable and applications

- 30C45** Special classes of univalent and multivalent functions of one complex variable (starlike, convex, bounded rotation, etc.)
- 30C50** Coefficient problems for univalent and multivalent functions of one complex variable
- 30C55** General theory of univalent and multivalent functions of one complex variable
- 30C62** Quasiconformal mappings in the complex plane
- 30C65** Quasiconformal mappings in \mathbb{R}^n , other generalizations
- 30C70** Extremal problems for conformal and quasiconformal mappings, variational methods
- 30C75** Extremal problems for conformal and quasiconformal mappings, other methods
- 30C80** Maximum principle, Schwarz's lemma, Lindelöf principle, analogues and generalizations; subordination
- 30C85** Capacity and harmonic measure in the complex plane [See also [31A15](#)]
- 30C99** None of the above, but in this section

30Dxx Entire and meromorphic functions of one complex variable, and related topics

- 30D05** Functional equations in the complex plane, iteration and composition of analytic functions of one complex variable [See also [34Mxx](#), [37Fxx](#), [39-XX](#)]
- 30D10** Representations of entire functions of one complex variable by series and integrals
- 30D15** Special classes of entire functions of one complex variable and growth estimates
- 30D20** Entire functions of one complex variable, general theory
- 30D30** Meromorphic functions of one complex variable, general theory
- 30D35** Value distribution of meromorphic functions of one complex variable, Nevanlinna theory
- 30D40** Cluster sets, prime ends, boundary behavior
- 30D45** Normal functions of one complex variable, normal families
- 30D60** Quasi-analytic and other classes of functions of one complex variable
- 30D99** None of the above, but in this section

30Exx Miscellaneous topics of analysis in the complex plane

- 30E05** Moment problems and interpolation problems in the complex plane
- 30E10** Approximation in the complex plane
- 30E15** Asymptotic representations in the complex plane
- 30E20** Integration, integrals of Cauchy type, integral representations of analytic functions in the complex plane [See also [45Exx](#)]
- 30E25** Boundary value problems in the complex plane [See also [45Exx](#)]
- 30E99** None of the above, but in this section

30Fxx Riemann surfaces

30F10 Compact Riemann surfaces and uniformization [See also [14H15](#), [32G15](#)]

30F15 Harmonic functions on Riemann surfaces

30F20 Classification theory of Riemann surfaces

30F25 Ideal boundary theory for Riemann surfaces

30F30 Differentials on Riemann surfaces

30F35 Fuchsian groups and automorphic functions (aspects of compact Riemann surfaces and uniformization) [See also [11Fxx](#), [20H10](#), [22E40](#), [32Gxx](#), [32Nxx](#)]

30F40 Kleinian groups (aspects of compact Riemann surfaces and uniformization) [See also [20H10](#)]

30F45 Conformal metrics (hyperbolic, Poincaré, distance functions)

30F50 Klein surfaces

30F60 Teichmüller theory [See also [32G15](#)]

30F99 None of the above, but in this section

30Gxx Generalized function theory

30G06 Non-Archimedean function theory [See also [12J25](#)]; nonstandard function theory [See also [03H05](#)]

30G12 Finely holomorphic functions and topological function theory

30G20 Generalizations of Bers and Vekua type (pseudoanalytic, p -analytic, etc.)

30G25 Discrete analytic functions

30G30 Other generalizations of analytic functions (including abstract-valued functions)

30G35 Functions of hypercomplex variables and generalized variables

30G99 None of the above, but in this section

30Hxx Spaces and algebras of analytic functions of one complex variable

30H05 Spaces of bounded analytic functions of one complex variable

30H10 Hardy spaces [See also [42B30](#), [46E30](#)]

30H15 Nevanlinna spaces and Smirnov spaces

30H20 Bergman spaces and Fock spaces [See also [46E30](#), [46E35](#)]

30H25 Besov spaces and Q_p -spaces

30H30 Bloch spaces

30H35 BMO-spaces

30H40 Zygmund spaces

30H45 de Branges-Rovnyak spaces

30H50 Algebras of analytic functions of one complex variable

30H80 Corona theorems

30H99 None of the above, but in this section

30Jxx Function theory on the disc

30J05 Inner functions of one complex variable

30J10 Blaschke products

30J15 Singular inner functions of one complex variable

30J99 None of the above, but in this section

30Kxx Universal holomorphic functions of one complex variable

30K05 Universal Taylor series in one complex variable

30K10 Universal Dirichlet series in one complex variable

30K15 Universal functions of one complex variable

30K20 Compositional universality

30K99 None of the above, but in this section

30Lxx Analysis on metric spaces

30L05 Geometric embeddings of metric spaces

30L10 Quasiconformal mappings in metric spaces

30L15 Inequalities in metric spaces

30L99 None of the above, but in this section

31-XX Potential theory {For probabilistic potential theory, see [60J45](#)}

31-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to potential theory

31-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to potential theory

31-02 Research exposition (monographs, survey articles) pertaining to potential theory

31-03 History of potential theory [Consider also classification numbers pertaining to [Section 01](#)]

31-04 Software, source code, etc. for problems pertaining to potential theory

31-06 Proceedings, conferences, collections, etc. pertaining to potential theory

31-08 Computational methods for problems pertaining to potential theory [See also [65Exx](#)]

31-11 Research data for problems pertaining to potential theory

31Axx Two-dimensional potential theory

31A05 Harmonic, subharmonic, superharmonic functions in two dimensions

31A10 Integral representations, integral operators, integral equations methods in two dimensions

31A15 Potentials and capacity, harmonic measure, extremal length and related notions in two dimensions [See also [30C85](#)]

31A20 Boundary behavior (theorems of Fatou type, etc.) of harmonic functions in two dimensions

31A25 Boundary value and inverse problems for harmonic functions in two dimensions

31A30 Biharmonic, polyharmonic functions and equations, Poisson's equation in two dimensions

31A35 Connections of harmonic functions with differential equations in two dimensions

31A99 None of the above, but in this section

31Bxx Higher-dimensional potential theory

31B05 Harmonic, subharmonic, superharmonic functions in higher dimensions

31B10 Integral representations, integral operators, integral equations methods in higher dimensions

31B15 Potentials and capacities, extremal length and related notions in higher dimensions

31B20 Boundary value and inverse problems for harmonic functions in higher dimensions

31B25 Boundary behavior of harmonic functions in higher dimensions

31B30 Biharmonic and polyharmonic equations and functions in higher dimensions

31B35 Connections of harmonic functions with differential equations in higher dimensions

31B99 None of the above, but in this section

31Cxx Generalizations of potential theory

31C05 Harmonic, subharmonic, superharmonic functions on other spaces

31C10 Pluriharmonic and plurisubharmonic functions [See also [32U05](#)]

31C12 Potential theory on Riemannian manifolds and other spaces [See also [53C20](#)] {For Hodge theory, see [58A14](#)}

31C15 Potentials and capacities on other spaces

31C20 Discrete potential theory

31C25 Dirichlet forms

31C35 Martin boundary theory [See also [60J50](#)]

31C40 Fine potential theory; fine properties of sets and functions

31C45 Other generalizations (nonlinear potential theory, etc.)

31C99 None of the above, but in this section

31Dxx Axiomatic potential theory

31D05 Axiomatic potential theory

31D99 None of the above, but in this section

31Exx Potential theory on fractals and metric spaces

31E05 Potential theory on fractals and metric spaces

31E99 None of the above, but in this section

32-XX Several complex variables and analytic spaces {For infinite-dimensional holomorphy, see also [46G20](#), [58B12](#)}

- 32-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to several complex variables and analytic spaces
- 32-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to several complex variables and analytic spaces
- 32-02** Research exposition (monographs, survey articles) pertaining to several complex variables and analytic spaces
- 32-03** History of several complex variables and analytic spaces [Consider also classification numbers pertaining to Section [01](#)]
- 32-04** Software, source code, etc. for problems pertaining to several complex variables and analytic spaces
- 32-06** Proceedings, conferences, collections, etc. pertaining to several complex variables and analytic spaces
- 32-08** Computational methods for problems pertaining to several complex variables and analytic spaces [See also [65Exx](#)]
- 32-11** Research data for problems pertaining to several complex variables and analytic spaces

32Axx Holomorphic functions of several complex variables

- 32A05** Power series, series of functions of several complex variables
- 32A08** Polynomials and rational functions of several complex variables
- 32A10** Holomorphic functions of several complex variables
- 32A12** Multifunctions of several complex variables
- 32A15** Entire functions of several complex variables
- 32A17** Special families of functions of several complex variables
- 32A18** Bloch functions, normal functions of several complex variables
- 32A19** Normal families of holomorphic functions, mappings of several complex variables, and related topics (taut manifolds etc.)
- 32A20** Meromorphic functions of several complex variables
- 32A22** Nevanlinna theory; growth estimates; other inequalities of several complex variables {For geometric theory, see [32H25](#), [32H30](#)}
- 32A25** Integral representations; canonical kernels (Szegő, Bergman, etc.)
- 32A26** Integral representations, constructed kernels (e.g., Cauchy, Fantappiè-type kernels)
- 32A27** Residues for several complex variables [See also [32C30](#)]
- 32A30** Other generalizations of function theory of one complex variable (should also be assigned at least one classification number from Section [30](#)) {For functions of several hypercomplex variables, see [30G35](#)}
- 32A35** H^p -spaces, Nevanlinna spaces of functions in several complex variables [See also [32M15](#), [42B30](#), [43A85](#), [46J15](#)]
- 32A36** Bergman spaces of functions in several complex variables

- 32A37** Other spaces of holomorphic functions of several complex variables (e.g., bounded mean oscillation (BMOA), vanishing mean oscillation (VMOA)) [See also [46Exx](#)]
- 32A38** Algebras of holomorphic functions of several complex variables [See also [46J10](#), [46J15](#)]
- 32A40** Boundary behavior of holomorphic functions of several complex variables
- 32A45** Hyperfunctions [See also [46F15](#)]
- 32A50** Harmonic analysis of several complex variables [See mainly [43-XX](#)]
- 32A55** Singular integrals of functions in several complex variables
- 32A60** Zero sets of holomorphic functions of several complex variables
- 32A65** Banach algebra techniques applied to functions of several complex variables [See also [46Jxx](#)]
- 32A70** Functional analysis techniques applied to functions of several complex variables [See also [46Exx](#)]
- 32A99** None of the above, but in this section
- 32Bxx Local analytic geometry** [See also [13-XX](#), [14-XX](#)]
- 32B05** Analytic algebras and generalizations, preparation theorems
- 32B10** Germs of analytic sets, local parametrization
- 32B15** Analytic subsets of affine space
- 32B20** Semi-analytic sets, subanalytic sets, and generalizations [See also [14P15](#)]
- 32B25** Triangulation and topological properties of semi-analytic and subanalytic sets, and related questions
- 32B99** None of the above, but in this section
- 32Cxx Analytic spaces**
- 32C05** Real-analytic manifolds, real-analytic spaces [See also [14Pxx](#), [58A07](#)]
- 32C07** Real-analytic sets, complex Nash functions [See also [14P15](#), [14P20](#)]
- 32C09** Embedding of real-analytic manifolds
- 32C11** Complex supergeometry [See also [14A22](#), [14M30](#), [58A50](#)]
- 32C15** Complex spaces
- 32C18** Topology of analytic spaces
- 32C20** Normal analytic spaces
- 32C22** Embedding of analytic spaces
- 32C25** Analytic subsets and submanifolds
- 32C30** Integration on analytic sets and spaces, currents [See also [32A25](#), [32A27](#)]
- 32C35** Analytic sheaves and cohomology groups [See also [14Fxx](#), [18F20](#), [55N30](#)]
- 32C36** Local cohomology of analytic spaces
- 32C37** Duality theorems for analytic spaces
- 32C38** Sheaves of differential operators and their modules, D -modules [See also [14F10](#), [16S32](#), [35A27](#), [58J15](#)]

- 32C55** The Levi problem in complex spaces; generalizations
- 32C81** Applications of analytic spaces to physics and other areas of science
- 32C99** None of the above, but in this section

32Dxx Analytic continuation

- 32D05** Domains of holomorphy
- 32D10** Envelopes of holomorphy
- 32D15** Continuation of analytic objects in several complex variables
- 32D20** Removable singularities in several complex variables
- 32D26** Riemann domains
- 32D99** None of the above, but in this section

32Exx Holomorphic convexity

- 32E05** Holomorphically convex complex spaces, reduction theory
- 32E10** Stein spaces, Stein manifolds
- 32E20** Polynomial convexity, rational convexity, meromorphic convexity in several complex variables
- 32E30** Holomorphic, polynomial and rational approximation, and interpolation in several complex variables; Runge pairs
- 32E35** Global boundary behavior of holomorphic functions of several complex variables
- 32E40** The Levi problem
- 32E99** None of the above, but in this section

32Fxx Geometric convexity in several complex variables

- 32F10** q -convexity, q -concavity
- 32F17** Other notions of convexity in relation to several complex variables
- 32F18** Finite-type conditions for the boundary of a domain
- 32F27** Topological consequences of geometric convexity
- 32F32** Analytical consequences of geometric convexity (vanishing theorems, etc.)
- 32F45** Invariant metrics and pseudodistances in several complex variables
- 32F99** None of the above, but in this section

32Gxx Deformations of analytic structures

- 32G05** Deformations of complex structures [See also [13D10](#), [16S80](#), [58H10](#), [58H15](#)]
- 32G07** Deformations of special (e.g., CR) structures
- 32G08** Deformations of fiber bundles
- 32G10** Deformations of submanifolds and subspaces
- 32G13** Complex-analytic moduli problems {For algebraic moduli problems, see [14D20](#), [14D22](#), [14H10](#), [14J10](#)} [See also [14H15](#), [14J15](#)]
- 32G15** Moduli of Riemann surfaces, Teichmüller theory (complex-analytic aspects in several variables) [See also [14H15](#), [30Fxx](#)]
- 32G20** Period matrices, variation of Hodge structure; degenerations [See also [14D05](#), [14D07](#), [14K30](#)]
- 32G34** Moduli and deformations for ordinary differential equations (e.g., Knizhnik-Zamolodchikov equation) [See also [34Mxx](#)]
- 32G81** Applications of deformations of analytic structures to the sciences
- 32G99** None of the above, but in this section

32Hxx Holomorphic mappings and correspondences

- 32H02** Holomorphic mappings, (holomorphic) embeddings and related questions in several complex variables
- 32H04** Meromorphic mappings in several complex variables
- 32H12** Boundary uniqueness of mappings in several complex variables
- 32H25** Picard-type theorems and generalizations for several complex variables {For function-theoretic properties, see [32A22](#)}
- 32H30** Value distribution theory in higher dimensions {For function-theoretic properties, see [32A22](#)}
- 32H35** Proper holomorphic mappings, finiteness theorems
- 32H40** Boundary regularity of mappings in several complex variables
- 32H50** Iteration of holomorphic maps, fixed points of holomorphic maps and related problems for several complex variables
- 32H99** None of the above, but in this section

32Jxx Compact analytic spaces {For Riemann surfaces, see [14Hxx](#), [30Fxx](#); for algebraic theory, see [14Jxx](#)}

- 32J05** Compactification of analytic spaces
- 32J10** Algebraic dependence theorems
- 32J15** Compact complex surfaces
- 32J17** Compact complex 3-folds
- 32J18** Compact complex n -folds
- 32J25** Transcendental methods of algebraic geometry (complex-analytic aspects) [See also [14C30](#)]
- 32J27** Compact Kähler manifolds: generalizations, classification
- 32J81** Applications of compact analytic spaces to the sciences
- 32J99** None of the above, but in this section

32Kxx Generalizations of analytic spaces

32K05 Banach analytic manifolds and spaces [See also [46G20](#), [58Bxx](#)]

32K07 Formal and graded complex spaces [See also [58C50](#)]

32K12 Holomorphic maps with infinite-dimensional arguments or values [See also [46G20](#)]

32K15 Differentiable functions on analytic spaces, differentiable spaces [See also [58C25](#)]

32K99 None of the above, but in this section

32Lxx Holomorphic fiber spaces [See also [55Rxx](#)]

32L05 Holomorphic bundles and generalizations

32L10 Sheaves and cohomology of sections of holomorphic vector bundles, general results [See also [14F06](#), [14H60](#), [14J60](#), [18F20](#), [55N30](#)]

32L15 Bundle convexity [See also [32F10](#)]

32L20 Vanishing theorems

32L25 Twistor theory, double fibrations (complex-analytic aspects) [See also [53C28](#)]

32L81 Applications of holomorphic fiber spaces to the sciences

32L99 None of the above, but in this section

32Mxx Complex spaces with a group of automorphisms

32M05 Complex Lie groups, group actions on complex spaces [See also [22E10](#)]

32M10 Homogeneous complex manifolds [See also [14M17](#), [57T15](#)]

32M12 Almost homogeneous manifolds and spaces [See also [14M17](#)]

32M15 Hermitian symmetric spaces, bounded symmetric domains, Jordan algebras (complex-analytic aspects) [See also [22E10](#), [22E40](#), [53C35](#), [57T15](#)]

32M17 Automorphism groups of \mathbb{C}^n and affine manifolds

32M18 Automorphism groups of other complex spaces

32M25 Complex vector fields, holomorphic foliations, \mathbb{C} -actions

32M99 None of the above, but in this section

32Nxx Automorphic functions [See also [11Fxx](#), [20H10](#), [22E40](#), [30F35](#)]

32N05 General theory of automorphic functions of several complex variables

32N10 Automorphic forms in several complex variables

32N15 Automorphic functions in symmetric domains

32N99 None of the above, but in this section

32Pxx Non-Archimedean analysis (should also be assigned at least one other classification number from Section 32 describing the type of problem)

32P05 Non-Archimedean analysis (should also be assigned at least one other classification number from Section 32 describing the type of problem)

32P99 None of the above, but in this section

32Qxx Complex manifolds

32Q02 Special domains (Reinhardt, Hartogs, circular, tube, etc.) in \mathbb{C}^n and complex manifolds

32Q05 Negative curvature complex manifolds

32Q10 Positive curvature complex manifolds

32Q15 Kähler manifolds

32Q20 Kähler-Einstein manifolds [See also 53Cxx]

32Q25 Calabi-Yau theory (complex-analytic aspects) [See also 14J32]

32Q26 Notions of stability for complex manifolds

32Q28 Stein manifolds

32Q30 Uniformization of complex manifolds

32Q35 Complex manifolds as subdomains of Euclidean space

32Q40 Embedding theorems for complex manifolds

32Q45 Hyperbolic and Kobayashi hyperbolic manifolds

32Q55 Topological aspects of complex manifolds

32Q56 Oka principle and Oka manifolds

32Q57 Classification theorems for complex manifolds

32Q60 Almost complex manifolds

32Q65 Pseudoholomorphic curves

32Q99 None of the above, but in this section

32Sxx Complex singularities [See also 58Kxx]

32S05 Local complex singularities [See also 14J17]

32S10 Invariants of analytic local rings

32S15 Equisingularity (topological and analytic) [See also 14E15]

32S20 Global theory of complex singularities; cohomological properties [See also 14E15]

32S22 Relations with arrangements of hyperplanes [See also 52C35]

32S25 Complex surface and hypersurface singularities [See also 14J17]

32S30 Deformations of complex singularities; vanishing cycles [See also 14B07]

32S35 Mixed Hodge theory of singular varieties (complex-analytic aspects) [See also 14C30, 14D07]

- 32S40** Monodromy; relations with differential equations and D -modules (complex-analytic aspects)
- 32S45** Modifications; resolution of singularities (complex-analytic aspects) [See also [14E15](#)]
- 32S50** Topological aspects of complex singularities: Lefschetz theorems, topological classification, invariants
- 32S55** Milnor fibration; relations with knot theory [See also [57K10](#), [57K45](#)]
- 32S60** Stratifications; constructible sheaves; intersection cohomology (complex-analytic aspects) [See also [58Kxx](#)]
- 32S65** Singularities of holomorphic vector fields and foliations
- 32S70** Other operations on complex singularities
- 32S99** None of the above, but in this section

32Txx Pseudoconvex domains

- 32T05** Domains of holomorphy
- 32T15** Strongly pseudoconvex domains
- 32T20** Worm domains
- 32T25** Finite-type domains
- 32T27** Geometric and analytic invariants on weakly pseudoconvex boundaries
- 32T35** Exhaustion functions
- 32T40** Peak functions
- 32T99** None of the above, but in this section

32Uxx Pluripotential theory

- 32U05** Plurisubharmonic functions and generalizations [See also [31C10](#)]
- 32U10** Plurisubharmonic exhaustion functions
- 32U15** General pluripotential theory
- 32U20** Capacity theory and generalizations
- 32U25** Lelong numbers
- 32U30** Removable sets in pluripotential theory
- 32U35** Plurisubharmonic extremal functions, pluricomplex Green functions
- 32U40** Currents
- 32U99** None of the above, but in this section

32Vxx CR manifolds

32V05 CR structures, CR operators, and generalizations

32V10 CR functions

32V15 CR manifolds as boundaries of domains

32V20 Analysis on CR manifolds

32V25 Extension of functions and other analytic objects from CR manifolds

32V30 Embeddings of CR manifolds

32V35 Finite-type conditions on CR manifolds

32V40 Real submanifolds in complex manifolds

32V99 None of the above, but in this section

32Wxx Differential operators in several variables

32W05 $\bar{\partial}$ and $\bar{\partial}$ -Neumann operators

32W10 $\bar{\partial}_b$ and $\bar{\partial}_b$ -Neumann operators

32W20 Complex Monge-Ampère operators

32W25 Pseudodifferential operators in several complex variables

32W30 Heat kernels in several complex variables

32W50 Other partial differential equations of complex analysis in several variables

32W99 None of the above, but in this section

33-XX Special functions (33-XX deals with the properties of functions as functions) {For orthogonal functions, see [42Cxx](#); for aspects of combinatorics, see [05Axx](#); for number-theoretic aspects, see [11-XX](#); for representation theory, see [22Exx](#)}

33-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to special functions

33-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to special functions

33-02 Research exposition (monographs, survey articles) pertaining to special functions

33-03 History of special functions [Consider also classification numbers pertaining to Section [01](#)]

33-04 Software, source code, etc. for problems pertaining to special functions

33-06 Proceedings, conferences, collections, etc. pertaining to special functions

33-11 Research data for problems pertaining to special functions

33Bxx Elementary classical functions

33B10 Exponential and trigonometric functions

33B15 Gamma, beta and polygamma functions

33B20 Incomplete beta and gamma functions (error functions, probability integral, Fresnel integrals)

33B30 Higher logarithm functions

33B99 None of the above, but in this section

33Cxx Hypergeometric functions

33C05 Classical hypergeometric functions, ${}_2F_1$

33C10 Bessel and Airy functions, cylinder functions, ${}_0F_1$

33C15 Confluent hypergeometric functions, Whittaker functions, ${}_1F_1$

33C20 Generalized hypergeometric series, ${}_pF_q$

33C45 Orthogonal polynomials and functions of hypergeometric type (Jacobi, Laguerre, Hermite, Askey scheme, etc.) {For general orthogonal polynomials and functions, see also [42C05](#)}

33C47 Other special orthogonal polynomials and functions

33C50 Orthogonal polynomials and functions in several variables expressible in terms of special functions in one variable

33C52 Orthogonal polynomials and functions associated with root systems

33C55 Spherical harmonics

33C60 Hypergeometric integrals and functions defined by them (E , G , H and I functions)

33C65 Appell, Horn and Lauricella functions

33C67 Hypergeometric functions associated with root systems

33C70 Other hypergeometric functions and integrals in several variables

33C75 Elliptic integrals as hypergeometric functions

33C80 Connections of hypergeometric functions with groups and algebras, and related topics

33C90 Applications of hypergeometric functions

33C99 None of the above, but in this section

33Dxx Basic hypergeometric functions

33D05 q -gamma functions, q -beta functions and integrals

33D15 Basic hypergeometric functions in one variable, ${}_r\phi_s$

33D45 Basic orthogonal polynomials and functions (Askey-Wilson polynomials, etc.)

33D50 Orthogonal polynomials and functions in several variables expressible in terms of basic hypergeometric functions in one variable

33D52 Basic orthogonal polynomials and functions associated with root systems (Macdonald polynomials, etc.)

33D60 Basic hypergeometric integrals and functions defined by them

- 33D65** Bibasic functions and multiple bases
- 33D67** Basic hypergeometric functions associated with root systems
- 33D70** Other basic hypergeometric functions and integrals in several variables
- 33D80** Connections of basic hypergeometric functions with quantum groups, Chevalley groups, p -adic groups, Hecke algebras, and related topics
- 33D90** Applications of basic hypergeometric functions
- 33D99** None of the above, but in this section

33Exx Other special functions

- 33E05** Elliptic functions and integrals
- 33E10** Lamé, Mathieu, and spheroidal wave functions
- 33E12** Mittag-Leffler functions and generalizations
- 33E15** Other wave functions
- 33E17** Painlevé-type functions
- 33E20** Other functions defined by series and integrals
- 33E30** Other functions coming from differential, difference and integral equations
- 33E50** Special functions in characteristic p (gamma functions, etc.)
- 33E99** None of the above, but in this section

33Fxx Computational aspects of special functions {For software etc., see [33-04](#)}

- 33F05** Numerical approximation and evaluation of special functions [See also [65D20](#)]
- 33F10** Symbolic computation of special functions (Gosper and Zeilberger algorithms, etc.) [See also [68W30](#)]
- 33F99** None of the above, but in this section

34-XX Ordinary differential equations

- 34-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to ordinary differential equations
- 34-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to ordinary differential equations
- 34-02** Research exposition (monographs, survey articles) pertaining to ordinary differential equations
- 34-03** History of ordinary differential equations [Consider also classification numbers pertaining to Section [01](#)]
- 34-04** Software, source code, etc. for problems pertaining to ordinary differential equations
- 34-06** Proceedings, conferences, collections, etc. pertaining to ordinary differential equations
- 34-11** Research data for problems pertaining to ordinary differential equations

34Axx General theory for ordinary differential equations

- 34A05** Explicit solutions, first integrals of ordinary differential equations
- 34A06** Generalized ordinary differential equations (measure-differential equations, set-valued differential equations, etc.)
- 34A07** Fuzzy ordinary differential equations
- 34A08** Fractional ordinary differential equations and fractional differential inclusions
- 34A09** Implicit ordinary differential equations, differential-algebraic equations
- 34A12** Initial value problems, existence, uniqueness, continuous dependence and continuation of solutions to ordinary differential equations
- 34A25** Analytical theory of ordinary differential equations: series, transformations, transforms, operational calculus, etc. [See also [44-XX](#)]
- 34A26** Geometric methods in ordinary differential equations
- 34A30** Linear ordinary differential equations and systems, general
- 34A33** Ordinary lattice differential equations
- 34A34** Nonlinear ordinary differential equations and systems, general theory
- 34A35** Ordinary differential equations of infinite order
- 34A36** Discontinuous ordinary differential equations
- 34A37** Ordinary differential equations with impulses
- 34A38** Hybrid systems of ordinary differential equations
- 34A40** Differential inequalities involving functions of a single real variable [See also [26D20](#)]
- 34A45** Theoretical approximation of solutions to ordinary differential equations {For numerical analysis, see [65Lxx](#)}
- 34A55** Inverse problems involving ordinary differential equations
- 34A60** Ordinary differential inclusions [See also [49J21](#), [49K21](#)]
- 34A99** None of the above, but in this section

34Bxx Boundary value problems for ordinary differential equations {For ordinary differential operators, see [34Lxx](#)}

- 34B05** Linear boundary value problems for ordinary differential equations
- 34B07** Linear boundary value problems for ordinary differential equations with nonlinear dependence on the spectral parameter
- 34B08** Parameter dependent boundary value problems for ordinary differential equations
- 34B09** Boundary eigenvalue problems for ordinary differential equations
- 34B10** Nonlocal and multipoint boundary value problems for ordinary differential equations
- 34B15** Nonlinear boundary value problems for ordinary differential equations
- 34B16** Singular nonlinear boundary value problems for ordinary differential equations
- 34B18** Positive solutions to nonlinear boundary value problems for ordinary differential equations

- 34B20** Weyl theory and its generalizations for ordinary differential equations
- 34B24** Sturm-Liouville theory [See also [34Lxx](#)]
- 34B27** Green's functions for ordinary differential equations
- 34B30** Special ordinary differential equations (Mathieu, Hill, Bessel, etc.)
- 34B37** Boundary value problems with impulses for ordinary differential equations
- 34B40** Boundary value problems on infinite intervals for ordinary differential equations
- 34B45** Boundary value problems on graphs and networks for ordinary differential equations
- 34B60** Applications of boundary value problems involving ordinary differential equations
- 34B99** None of the above, but in this section

34Cxx Qualitative theory for ordinary differential equations [See also [37-XX](#)]

- 34C05** Topological structure of integral curves, singular points, limit cycles of ordinary differential equations
- 34C07** Theory of limit cycles of polynomial and analytic vector fields (existence, uniqueness, bounds, Hilbert's 16th problem and ramifications) for ordinary differential equations
- 34C08** Ordinary differential equations and connections with real algebraic geometry (fewnomials, desingularization, zeros of abelian integrals, etc.)
- 34C10** Oscillation theory, zeros, disconjugacy and comparison theory for ordinary differential equations
- 34C11** Growth and boundedness of solutions to ordinary differential equations
- 34C12** Monotone systems involving ordinary differential equations
- 34C14** Symmetries, invariants of ordinary differential equations
- 34C15** Nonlinear oscillations and coupled oscillators for ordinary differential equations
- 34C20** Transformation and reduction of ordinary differential equations and systems, normal forms
- 34C23** Bifurcation theory for ordinary differential equations [See also [37Gxx](#)]
- 34C25** Periodic solutions to ordinary differential equations
- 34C26** Relaxation oscillations for ordinary differential equations
- 34C27** Almost and pseudo-almost periodic solutions to ordinary differential equations
- 34C28** Complex behavior and chaotic systems of ordinary differential equations [See also [37Dxx](#)]
- 34C29** Averaging method for ordinary differential equations
- 34C37** Homoclinic and heteroclinic solutions to ordinary differential equations
- 34C40** Ordinary differential equations and systems on manifolds
- 34C41** Equivalence and asymptotic equivalence of ordinary differential equations
- 34C45** Invariant manifolds for ordinary differential equations
- 34C46** Multifrequency systems of ordinary differential equations
- 34C55** Hysteresis for ordinary differential equations
- 34C60** Qualitative investigation and simulation of ordinary differential equation models
- 34C99** None of the above, but in this section

34Dxx Stability theory for ordinary differential equations [See also [37C75](#), [93Dxx](#)]

34D05 Asymptotic properties of solutions to ordinary differential equations

34D06 Synchronization of solutions to ordinary differential equations

34D08 Characteristic and Lyapunov exponents of ordinary differential equations

34D09 Dichotomy, trichotomy of solutions to ordinary differential equations

34D10 Perturbations of ordinary differential equations

34D15 Singular perturbations of ordinary differential equations

34D20 Stability of solutions to ordinary differential equations

34D23 Global stability of solutions to ordinary differential equations

34D30 Structural stability and analogous concepts of solutions to ordinary differential equations [See also [37C20](#)]

34D35 Stability of manifolds of solutions to ordinary differential equations

34D45 Attractors of solutions to ordinary differential equations [See also [37C70](#), [37D45](#)]

34D99 None of the above, but in this section

34Exx Asymptotic theory for ordinary differential equations

34E05 Asymptotic expansions of solutions to ordinary differential equations

34E10 Perturbations, asymptotics of solutions to ordinary differential equations

34E13 Multiple scale methods for ordinary differential equations

34E15 Singular perturbations, general theory for ordinary differential equations

34E17 Canard solutions to ordinary differential equations

34E18 Methods of nonstandard analysis for ordinary differential equations

34E20 Singular perturbations, turning point theory, WKB methods for ordinary differential equations

34E99 None of the above, but in this section

34Fxx Ordinary differential equations and systems with randomness [See also [34K50](#), [60H10](#), [93E03](#)]

34F05 Ordinary differential equations and systems with randomness [See also [34K50](#), [60H10](#), [93E03](#)]

34F10 Bifurcation of solutions to ordinary differential equations involving randomness

34F15 Resonance phenomena for ordinary differential equations involving randomness

34F99 None of the above, but in this section

34Gxx Differential equations in abstract spaces [See also [34Lxx](#), [37Kxx](#), [47Dxx](#), [47Hxx](#), [47Jxx](#), [58D25](#)]

34G10 Linear differential equations in abstract spaces [See also [47D06](#), [47D09](#)]

34G20 Nonlinear differential equations in abstract spaces [See also [47Hxx](#), [47Jxx](#)]

34G25 Evolution inclusions

34G99 None of the above, but in this section

34Hxx Control problems including ordinary differential equations [See also [49J15](#), [49K15](#), [93C15](#)]

34H05 Control problems involving ordinary differential equations [See also [49J15](#), [49K15](#), [93C15](#)]

34H10 Chaos control for problems involving ordinary differential equations

34H15 Stabilization of solutions to ordinary differential equations

34H20 Bifurcation control of ordinary differential equations

34H99 None of the above, but in this section

34Kxx Functional-differential equations (including equations with delayed, advanced or state-dependent argument)

34K04 Symmetries, invariants of functional-differential equations [See also [37C80](#)]

34K05 General theory of functional-differential equations

34K06 Linear functional-differential equations

34K07 Theoretical approximation of solutions to functional-differential equations

34K08 Spectral theory of functional-differential operators

34K09 Functional-differential inclusions

34K10 Boundary value problems for functional-differential equations

34K11 Oscillation theory of functional-differential equations

34K12 Growth, boundedness, comparison of solutions to functional-differential equations [See also [37C35](#)]

34K13 Periodic solutions to functional-differential equations [See also [37C27](#)]

34K14 Almost and pseudo-almost periodic solutions to functional-differential equations

34K16 Heteroclinic and homoclinic orbits of functional-differential equations [See also [37C29](#)]

34K17 Transformation and reduction of functional-differential equations and systems, normal forms

34K18 Bifurcation theory of functional-differential equations [See also [37Gxx](#)]

34K19 Invariant manifolds of functional-differential equations

34K20 Stability theory of functional-differential equations [See also [37C75](#)]

34K21 Stationary solutions of functional-differential equations

34K23 Complex (chaotic) behavior of solutions to functional-differential equations [See also [37D45](#)]

34K24 Synchronization of functional-differential equations

34K25 Asymptotic theory of functional-differential equations

34K26 Singular perturbations of functional-differential equations

34K27 Perturbations of functional-differential equations

34K29 Inverse problems for functional-differential equations

34K30 Functional-differential equations in abstract spaces [See also [34Gxx](#), [35R09](#), [35R10](#), [47Jxx](#)]

- 34K31** Lattice functional-differential equations
- 34K32** Implicit functional-differential equations
- 34K33** Averaging for functional-differential equations
- 34K34** Hybrid systems of functional-differential equations
- 34K35** Control problems for functional-differential equations [See also [49J21](#), [49K21](#), [93C23](#)]
- 34K36** Fuzzy functional-differential equations
- 34K37** Functional-differential equations with fractional derivatives
- 34K38** Functional-differential inequalities
- 34K39** Discontinuous functional-differential equations
- 34K40** Neutral functional-differential equations
- 34K41** Functional-differential equations in the complex domain
- 34K42** Functional-differential equations on time scales or measure chains
- 34K43** Functional-differential equations with state-dependent arguments
- 34K45** Functional-differential equations with impulses
- 34K50** Stochastic functional-differential equations [See also [34Fxx](#), [60Hxx](#)]
- 34K60** Qualitative investigation and simulation of models involving functional-differential equations
- 34K99** None of the above, but in this section

34Lxx Ordinary differential operators [See also [47E05](#)]

- 34L05** General spectral theory of ordinary differential operators
- 34L10** Eigenfunctions, eigenfunction expansions, completeness of eigenfunctions of ordinary differential operators
- 34L15** Eigenvalues, estimation of eigenvalues, upper and lower bounds of ordinary differential operators
- 34L16** Numerical approximation of eigenvalues and of other parts of the spectrum of ordinary differential operators
- 34L20** Asymptotic distribution of eigenvalues, asymptotic theory of eigenfunctions for ordinary differential operators
- 34L25** Scattering theory, inverse scattering involving ordinary differential operators
- 34L30** Nonlinear ordinary differential operators
- 34L40** Particular ordinary differential operators (Dirac, one-dimensional Schrödinger, etc.)
- 34L99** None of the above, but in this section

34Mxx Ordinary differential equations in the complex domain [See also [30Dxx](#), [32G34](#)]

- 34M03** Linear ordinary differential equations and systems in the complex domain
- 34M04** Nonlinear ordinary differential equations and systems in the complex domain
- 34M05** Entire and meromorphic solutions to ordinary differential equations in the complex domain
- 34M10** Oscillation, growth of solutions to ordinary differential equations in the complex domain
- 34M15** Algebraic aspects (differential-algebraic, hypertranscendence, group-theoretical) of ordinary differential equations in the complex domain
- 34M25** Formal solutions and transform techniques for ordinary differential equations in the complex domain
- 34M30** Asymptotics and summation methods for ordinary differential equations in the complex domain
- 34M35** Singularities, monodromy and local behavior of solutions to ordinary differential equations in the complex domain, normal forms
- 34M40** Stokes phenomena and connection problems (linear and nonlinear) for ordinary differential equations in the complex domain
- 34M45** Ordinary differential equations on complex manifolds
- 34M46** Spectral theory for ordinary differential operators in the complex domain
- 34M50** Inverse problems (Riemann-Hilbert, inverse differential Galois, etc.) for ordinary differential equations in the complex domain
- 34M55** Painlevé and other special ordinary differential equations in the complex domain; classification, hierarchies;
- 34M56** Isomonodromic deformations for ordinary differential equations in the complex domain
- 34M60** Singular perturbation problems for ordinary differential equations in the complex domain (complex WKB, turning points, steepest descent) [See also [34E20](#)]
- 34M65** Topological structure of trajectories of ordinary differential equations in the complex domain
- 34M99** None of the above, but in this section

34Nxx Dynamic equations on time scales or measure chains {For real analysis on time scales, see [26E70](#)}

- 34N05** Dynamic equations on time scales or measure chains {For real analysis on time scales or measure chains, see [26E70](#)}
- 34N99** None of the above, but in this section

35-XX Partial differential equations

- 35-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to partial differential equations
- 35-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to partial differential equations
- 35-02** Research exposition (monographs, survey articles) pertaining to partial differential equations
- 35-03** History of partial differential equations [Consider also classification numbers pertaining to [Section 01](#)]
- 35-04** Software, source code, etc. for problems pertaining to partial differential equations
- 35-06** Proceedings, conferences, collections, etc. pertaining to partial differential equations
- 35-11** Research data for problems pertaining to partial differential equations

35Axx General topics in partial differential equations

- 35A01** Existence problems for PDEs: global existence, local existence, non-existence
- 35A02** Uniqueness problems for PDEs: global uniqueness, local uniqueness, non-uniqueness
- 35A08** Fundamental solutions to PDEs
- 35A09** Classical solutions to PDEs
- 35A10** Cauchy-Kovalevskaya theorems
- 35A15** Variational methods applied to PDEs
- 35A16** Topological and monotonicity methods applied to PDEs
- 35A17** Parametrices in context of PDEs
- 35A18** Wave front sets in context of PDEs
- 35A20** Analyticity in context of PDEs
- 35A21** Singularity in context of PDEs
- 35A22** Transform methods (e.g., integral transforms) applied to PDEs
- 35A23** Inequalities applied to PDEs involving derivatives, differential and integral operators, or integrals
- 35A24** Methods of ordinary differential equations applied to PDEs
- 35A25** Other special methods applied to PDEs
- 35A27** Microlocal methods and methods of sheaf theory and homological algebra applied to PDEs [See also [32C38](#), [58J15](#)]
- 35A30** Geometric theory, characteristics, transformations in context of PDEs [See also [58J70](#), [58J72](#)]
- 35A35** Theoretical approximation in context of PDEs {For numerical analysis, see [65Mxx](#), [65Nxx](#)}
- 35A99** None of the above, but in this section

35Bxx Qualitative properties of solutions to partial differential equations

- 35B05** Oscillation, zeros of solutions, mean value theorems, etc. in context of PDEs
- 35B06** Symmetries, invariants, etc. in context of PDEs
- 35B07** Axially symmetric solutions to PDEs
- 35B08** Entire solutions to PDEs
- 35B09** Positive solutions to PDEs
- 35B10** Periodic solutions to PDEs
- 35B15** Almost and pseudo-almost periodic solutions to PDEs
- 35B20** Perturbations in context of PDEs
- 35B25** Singular perturbations in context of PDEs
- 35B27** Homogenization in context of PDEs; PDEs in media with periodic structure [See also [74Q05](#), [74Q10](#), [76M50](#), [78M40](#), [80M40](#)]

- 35B30** Dependence of solutions to PDEs on initial and/or boundary data and/or on parameters of PDEs [See also [37Cxx](#)]
- 35B32** Bifurcations in context of PDEs [See also [34C23](#), [34F10](#), [34H20](#), [37F46](#), [37Gxx](#), [37H20](#), [35J20](#), [37L10](#), [37M20](#), [47J15](#), [58E05](#), [58E07](#), [58J55](#), [74G60](#), [74H60](#)]
- 35B33** Critical exponents in context of PDEs
- 35B34** Resonance in context of PDEs [See also [34F15](#), [70J40](#), [70K28](#), [70K30](#), [81U24](#)]
- 35B35** Stability in context of PDEs [See also [34Dxx](#), [37B25](#), [37C20](#), [37C75](#), [37F15](#), [37J25](#), [37K45](#), [37L15](#), [49K40](#), [58K25](#), [93Dxx](#)]
- 35B36** Pattern formations in context of PDEs [See also [92C15](#)]
- 35B38** Critical points of functionals in context of PDEs (e.g., energy functionals) [See also [57R70](#), [58K05](#), [58E05](#)]
- 35B40** Asymptotic behavior of solutions to PDEs
- 35B41** Attractors [See also [34D45](#), [37B35](#), [37C70](#), [37D45](#), [37G35](#), [37L30](#), [37M22](#)]
- 35B42** Inertial manifolds [See also [37L25](#)]
- 35B44** Blow-up in context of PDEs
- 35B45** A priori estimates in context of PDEs
- 35B50** Maximum principles in context of PDEs
- 35B51** Comparison principles in context of PDEs
- 35B53** Liouville theorems and Phragmén-Lindelöf theorems in context of PDEs
- 35B60** Continuation and prolongation of solutions to PDEs [See also [58A15](#), [58A17](#), [58Hxx](#)]
- 35B65** Smoothness and regularity of solutions to PDEs
- 35B99** None of the above, but in this section

35Cxx Representations of solutions to partial differential equations

- 35C05** Solutions to PDEs in closed form
- 35C06** Self-similar solutions to PDEs
- 35C07** Traveling wave solutions
- 35C08** Soliton solutions [See also [37K40](#)]
- 35C09** Trigonometric solutions to PDEs
- 35C10** Series solutions to PDEs
- 35C11** Polynomial solutions to PDEs
- 35C15** Integral representations of solutions to PDEs
- 35C20** Asymptotic expansions of solutions to PDEs
- 35C99** None of the above, but in this section

35Dxx Generalized solutions to partial differential equations

35D30 Weak solutions to PDEs

35D35 Strong solutions to PDEs

35D40 Viscosity solutions to PDEs

35D99 None of the above, but in this section

35Exx Partial differential equations and systems of partial differential equations with constant coefficients [See also [35N05](#)]

35E05 Fundamental solutions to PDEs and systems of PDEs with constant coefficients

35E10 Convexity properties of solutions to PDEs and systems of PDEs with constant coefficients

35E15 Initial value problems for PDEs and systems of PDEs with constant coefficients

35E20 General theory of PDEs and systems of PDEs with constant coefficients

35E99 None of the above, but in this section

35Fxx General first-order partial differential equations and systems of first-order partial differential equations

35F05 Linear first-order PDEs

35F10 Initial value problems for linear first-order PDEs

35F15 Boundary value problems for linear first-order PDEs

35F16 Initial-boundary value problems for linear first-order PDEs

35F20 Nonlinear first-order PDEs

35F21 Hamilton-Jacobi equations {For calculus of variations and optimal control, see [49Lxx](#); for mechanics of particles and systems, see [70H20](#)}

35F25 Initial value problems for nonlinear first-order PDEs

35F30 Boundary value problems for nonlinear first-order PDEs

35F31 Initial-boundary value problems for nonlinear first-order PDEs

35F35 Systems of linear first-order PDEs

35F40 Initial value problems for systems of linear first-order PDEs

35F45 Boundary value problems for systems of linear first-order PDEs

35F46 Initial-boundary value problems for systems of linear first-order PDEs

35F50 Systems of nonlinear first-order PDEs

35F55 Initial value problems for systems of nonlinear first-order PDEs

35F60 Boundary value problems for systems of nonlinear first-order PDEs

35F61 Initial-boundary value problems for systems of nonlinear first-order PDEs

35F99 None of the above, but in this section

35Gxx General higher-order partial differential equations and systems of higher-order partial differential equations

35G05 Linear higher-order PDEs

35G10 Initial value problems for linear higher-order PDEs

35G15 Boundary value problems for linear higher-order PDEs

35G16 Initial-boundary value problems for linear higher-order PDEs

35G20 Nonlinear higher-order PDEs

35G25 Initial value problems for nonlinear higher-order PDEs

35G30 Boundary value problems for nonlinear higher-order PDEs

35G31 Initial-boundary value problems for nonlinear higher-order PDEs

35G35 Systems of linear higher-order PDEs

35G40 Initial value problems for systems of linear higher-order PDEs

35G45 Boundary value problems for systems of linear higher-order PDEs

35G46 Initial-boundary value problems for systems of linear higher-order PDEs

35G50 Systems of nonlinear higher-order PDEs

35G55 Initial value problems for systems of nonlinear higher-order PDEs

35G60 Boundary value problems for systems of nonlinear higher-order PDEs

35G61 Initial-boundary value problems for systems of nonlinear higher-order PDEs

35G99 None of the above, but in this section

35Hxx Close-to-elliptic equations

35H10 Hypoelliptic equations

35H20 Subelliptic equations

35H30 Quasielliptic equations

35H99 None of the above, but in this section

35Jxx Elliptic equations and elliptic systems {For global analysis, analysis on manifolds, see [58J10](#), [58J20](#)}

35J05 Laplace operator, Helmholtz equation (reduced wave equation), Poisson equation [See also [31Axx](#), [31Bxx](#)]

35J08 Green's functions for elliptic equations

35J10 Schrödinger operator, Schrödinger equation {For ordinary differential equations, see [34L40](#); for operator theory, see [47D08](#); for quantum theory, see [81Q05](#); for statistical mechanics, see [82B44](#)}

35J15 Second-order elliptic equations

35J20 Variational methods for second-order elliptic equations

35J25 Boundary value problems for second-order elliptic equations

- 35J30** Higher-order elliptic equations [See also [31A30](#), [31B30](#)]
- 35J35** Variational methods for higher-order elliptic equations
- 35J40** Boundary value problems for higher-order elliptic equations
- 35J46** First-order elliptic systems
- 35J47** Second-order elliptic systems
- 35J48** Higher-order elliptic systems
- 35J50** Variational methods for elliptic systems
- 35J56** Boundary value problems for first-order elliptic systems
- 35J57** Boundary value problems for second-order elliptic systems
- 35J58** Boundary value problems for higher-order elliptic systems
- 35J60** Nonlinear elliptic equations
- 35J61** Semilinear elliptic equations
- 35J62** Quasilinear elliptic equations
- 35J65** Nonlinear boundary value problems for linear elliptic equations
- 35J66** Nonlinear boundary value problems for nonlinear elliptic equations
- 35J67** Boundary values of solutions to elliptic equations and elliptic systems
- 35J70** Degenerate elliptic equations
- 35J75** Singular elliptic equations
- 35J86** Unilateral problems for linear elliptic equations and variational inequalities with linear elliptic operators [See also [35R35](#), [49J40](#)]
- 35J87** Unilateral problems for nonlinear elliptic equations and variational inequalities with nonlinear elliptic operators [See also [35R35](#), [49J40](#)]
- 35J88** Unilateral problems for elliptic systems and systems of variational inequalities with elliptic operators [See also [35R35](#), [49J40](#)]
- 35J91** Semilinear elliptic equations with Laplacian, bi-Laplacian or poly-Laplacian
- 35J92** Quasilinear elliptic equations with p -Laplacian
- 35J93** Quasilinear elliptic equations with mean curvature operator
- 35J94** Elliptic equations with infinity-Laplacian
- 35J96** Monge-Ampère equations {For complex Monge-Ampère operators, see [32W20](#); for parabolic Monge-Ampère equations, see [35K96](#)}
- 35J99** None of the above, but in this section

35Kxx Parabolic equations and parabolic systems {For global analysis, analysis on manifolds, see [58J35](#)}

35K05 Heat equation

35K08 Heat kernel

35K10 Second-order parabolic equations

35K15 Initial value problems for second-order parabolic equations

35K20 Initial-boundary value problems for second-order parabolic equations

35K25 Higher-order parabolic equations

35K30 Initial value problems for higher-order parabolic equations

35K35 Initial-boundary value problems for higher-order parabolic equations

35K40 Second-order parabolic systems

35K41 Higher-order parabolic systems

35K45 Initial value problems for second-order parabolic systems

35K46 Initial value problems for higher-order parabolic systems

35K51 Initial-boundary value problems for second-order parabolic systems

35K52 Initial-boundary value problems for higher-order parabolic systems

35K55 Nonlinear parabolic equations

35K57 Reaction-diffusion equations {For diffusion processes and reaction effects, see [47D07](#), [58J65](#), [60J60](#), [60J70](#), [74N25](#), [76R50](#), [76V05](#), [80A23](#), [82B24](#), [82C24](#), [92E20](#)}

35K58 Semilinear parabolic equations

35K59 Quasilinear parabolic equations

35K60 Nonlinear initial, boundary and initial-boundary value problems for linear parabolic equations

35K61 Nonlinear initial, boundary and initial-boundary value problems for nonlinear parabolic equations

35K65 Degenerate parabolic equations

35K67 Singular parabolic equations

35K70 Ultraparabolic equations, pseudoparabolic equations, etc.

35K85 Unilateral problems for linear parabolic equations and variational inequalities with linear parabolic operators [See also [35R35](#), [49J40](#)]

35K86 Unilateral problems for nonlinear parabolic equations and variational inequalities with nonlinear parabolic operators [See also [35R35](#), [49J40](#)]

35K87 Unilateral problems for parabolic systems and systems of variational inequalities with parabolic operators [See also [35R35](#), [49J40](#)]

35K90 Abstract parabolic equations

35K91 Semilinear parabolic equations with Laplacian, bi-Laplacian or poly-Laplacian

35K92 Quasilinear parabolic equations with p -Laplacian

35K93 Quasilinear parabolic equations with mean curvature operator

35K96 Parabolic Monge-Ampère equations

35K99 None of the above, but in this section

- 35Lxx Hyperbolic equations and hyperbolic systems** {For global analysis, see [58J45](#)}
- 35L02** First-order hyperbolic equations
 - 35L03** Initial value problems for first-order hyperbolic equations
 - 35L04** Initial-boundary value problems for first-order hyperbolic equations
 - 35L05** Wave equation
 - 35L10** Second-order hyperbolic equations
 - 35L15** Initial value problems for second-order hyperbolic equations
 - 35L20** Initial-boundary value problems for second-order hyperbolic equations
 - 35L25** Higher-order hyperbolic equations
 - 35L30** Initial value problems for higher-order hyperbolic equations
 - 35L35** Initial-boundary value problems for higher-order hyperbolic equations
 - 35L40** First-order hyperbolic systems
 - 35L45** Initial value problems for first-order hyperbolic systems
 - 35L50** Initial-boundary value problems for first-order hyperbolic systems
 - 35L51** Second-order hyperbolic systems
 - 35L52** Initial value problems for second-order hyperbolic systems
 - 35L53** Initial-boundary value problems for second-order hyperbolic systems
 - 35L55** Higher-order hyperbolic systems
 - 35L56** Initial value problems for higher-order hyperbolic systems
 - 35L57** Initial-boundary value problems for higher-order hyperbolic systems
 - 35L60** First-order nonlinear hyperbolic equations
 - 35L65** Hyperbolic conservation laws
 - 35L67** Shocks and singularities for hyperbolic equations [See also [58Kxx](#), [74J40](#), [76L05](#)]
 - 35L70** Second-order nonlinear hyperbolic equations
 - 35L71** Second-order semilinear hyperbolic equations
 - 35L72** Second-order quasilinear hyperbolic equations
 - 35L75** Higher-order nonlinear hyperbolic equations
 - 35L76** Higher-order semilinear hyperbolic equations
 - 35L77** Higher-order quasilinear hyperbolic equations
 - 35L80** Degenerate hyperbolic equations
 - 35L81** Singular hyperbolic equations
 - 35L82** Pseudohyperbolic equations
 - 35L85** Unilateral problems for linear hyperbolic equations and variational inequalities with linear hyperbolic operators [See also [35R35](#), [49J40](#)]

35L86 Unilateral problems for nonlinear hyperbolic equations and variational inequalities with nonlinear hyperbolic operators [See also [35R35](#), [49J40](#)]

35L87 Unilateral problems for hyperbolic systems and systems of variational inequalities with hyperbolic operators [See also [35R35](#), [49J40](#)]

35L90 Abstract hyperbolic equations

35L99 None of the above, but in this section

35Mxx Partial differential equations of mixed type and mixed-type systems of partial differential equations

35M10 PDEs of mixed type

35M11 Initial value problems for PDEs of mixed type

35M12 Boundary value problems for PDEs of mixed type

35M13 Initial-boundary value problems for PDEs of mixed type

35M30 Mixed-type systems of PDEs

35M31 Initial value problems for mixed-type systems of PDEs

35M32 Boundary value problems for mixed-type systems of PDEs

35M33 Initial-boundary value problems for mixed-type systems of PDEs

35M85 Unilateral problems for linear PDEs of mixed type and variational inequalities with partial differential operators of mixed type [See also [35R35](#), [49J40](#)]

35M86 Unilateral problems for nonlinear PDEs of mixed type and variational inequalities with nonlinear partial differential operators of mixed type [See also [35R35](#), [49J40](#)]

35M87 Unilateral problems for mixed-type systems of PDEs and systems of variational inequalities with partial differential operators of mixed type [See also [35R35](#), [49J40](#)]

35M99 None of the above, but in this section

35Nxx Overdetermined problems for partial differential equations and systems of partial differential equations {For global analysis, see [58Hxx](#), [58J10](#), [58J15](#)}

35N05 Overdetermined systems of PDEs with constant coefficients

35N10 Overdetermined systems of PDEs with variable coefficients

35N15 $\bar{\partial}$ -Neumann problems and formal complexes in context of PDEs [See also [32W05](#), [32W10](#), [58J10](#)]

35N20 Overdetermined initial value problems for PDEs and systems of PDEs

35N25 Overdetermined boundary value problems for PDEs and systems of PDEs

35N30 Overdetermined initial-boundary value problems for PDEs and systems of PDEs

35N99 None of the above, but in this section

35Pxx Spectral theory and eigenvalue problems for partial differential equations {For operator theory, see [47Axx](#), [47Bxx](#), [47F05](#)}

35P05 General topics in linear spectral theory for PDEs

35P10 Completeness of eigenfunctions and eigenfunction expansions in context of PDEs

35P15 Estimates of eigenvalues in context of PDEs

35P20 Asymptotic distributions of eigenvalues in context of PDEs

35P25 Scattering theory for PDEs [See also [47A40](#)]

35P30 Nonlinear eigenvalue problems and nonlinear spectral theory for PDEs

35P99 None of the above, but in this section

35Qxx Partial differential equations of mathematical physics and other areas of application [See also [35J05](#), [35J10](#), [35K05](#), [35L05](#)]

35Q05 Euler-Poisson-Darboux equations

35Q07 Fuchsian PDEs

35Q15 Riemann-Hilbert problems in context of PDEs [See also [30E25](#), [31A25](#), [31B20](#)]

35Q20 Boltzmann equations {For fluid mechanics, see [76P05](#); for statistical mechanics, see [82B40](#), [82C40](#), [82D05](#)}

35Q30 Navier-Stokes equations {For fluid mechanics, see [76D05](#), [76D07](#), [76N10](#)}

35Q31 Euler equations {For fluid mechanics, see [76D05](#), [76D07](#), [76N10](#)}

35Q35 PDEs in connection with fluid mechanics

35Q40 PDEs in connection with quantum mechanics

35Q41 Time-dependent Schrödinger equations and Dirac equations {For quantum theory, see [81Q05](#); for relativity and gravitational theory, see [83A05](#), [83C10](#)}

35Q51 Soliton equations {For dynamical systems and ergodic theory, see [37K40](#)}

35Q53 KdV equations (Korteweg-de Vries equations) {For dynamical systems and ergodic theory, see [37K10](#)}

35Q55 NLS equations (nonlinear Schrödinger equations) {For dynamical systems and ergodic theory, see [37K10](#)}

35Q56 Ginzburg-Landau equations {For optics and electromagnetic theory, see [78A25](#)}

35Q60 PDEs in connection with optics and electromagnetic theory

35Q61 Maxwell equations {For optics and electromagnetic theory, see [78A25](#); for relativity and gravitational theory, see [83C22](#)}

35Q62 PDEs in connection with statistics

35Q68 PDEs in connection with computer science

35Q70 PDEs in connection with mechanics of particles and systems of particles

35Q74 PDEs in connection with mechanics of deformable solids

35Q75 PDEs in connection with relativity and gravitational theory

35Q76 Einstein equations {For several complex variables and analytic spaces, see [32Q40](#); for differential geometry, see [53C07](#); for relativity and gravitational theory, see [83C05](#), [83C25](#), [83D05](#)}

- 35Q79** PDEs in connection with classical thermodynamics and heat transfer
- 35Q80** Transport equations {For calculus of variations and optimal control, see [49Q20](#); for fluid mechanics, see [76F25](#); for statistical mechanics, see [82C70](#), [82D75](#); for operations research, see [90B06](#); for mathematical programming, see [90C08](#)}
- 35Q81** PDEs in connection with semiconductor devices {For statistical mechanics, see [82D37](#)}
- 35Q82** PDEs in connection with statistical mechanics
- 35Q83** Vlasov equations {For statistical mechanics, see [82C70](#), [82D75](#)}
- 35Q84** Fokker-Planck equations {For fluid mechanics, see [76X05](#), [76W05](#); for statistical mechanics, see [82C31](#)}
- 35Q85** PDEs in connection with astronomy and astrophysics
- 35Q86** PDEs in connection with geophysics
- 35Q89** PDEs in connection with mean field game theory {For calculus of variations and optimal control, see [49N80](#); for game theory, see [91A16](#)}
- 35Q90** PDEs in connection with mathematical programming
- 35Q91** PDEs in connection with game theory, economics, social and behavioral sciences
- 35Q92** PDEs in connection with biology, chemistry and other natural sciences
- 35Q93** PDEs in connection with control and optimization
- 35Q94** PDEs in connection with information and communication
- 35Q99** None of the above, but in this section
- 35Rxx** **Miscellaneous topics in partial differential equations** {For equations on manifolds, see [32Wxx](#), [58Jxx](#); for manifolds of solutions, see [58Bxx](#); for stochastic PDEs, see [60H15](#)}
- 35R01** PDEs on manifolds [See also [32Wxx](#), [53Cxx](#), [58Jxx](#)]
- 35R02** PDEs on graphs and networks (ramified or polygonal spaces)
- 35R03** PDEs on Heisenberg groups, Lie groups, Carnot groups, etc.
- 35R05** PDEs with low regular coefficients and/or low regular data
- 35R06** PDEs with measure
- 35R07** PDEs on time scales
- 35R09** Integral partial differential equations [See also [45Kxx](#)]
- 35R10** Functional partial differential equations
- 35R11** Fractional partial differential equations
- 35R12** Impulsive partial differential equations
- 35R13** Fuzzy partial differential equations
- 35R15** PDEs on infinite-dimensional (e.g., function) spaces (= PDEs in infinitely many variables) [See also [46Gxx](#), [58D25](#)]

- 35R20** Operator partial differential equations (= PDEs on finite-dimensional spaces for abstract space valued functions) [See also [34Gxx](#), [47A50](#), [47D03](#), [47D06](#), [47D09](#), [47H20](#), [47Jxx](#)]
- 35R25** Ill-posed problems for PDEs
- 35R30** Inverse problems for PDEs
- 35R35** Free boundary problems for PDEs
- 35R37** Moving boundary problems for PDEs
- 35R45** Partial differential inequalities and systems of partial differential inequalities
- 35R50** PDEs of infinite order
- 35R60** PDEs with randomness, stochastic partial differential equations [See also [60H15](#)]
- 35R70** PDEs with multivalued right-hand sides
- 35R99** None of the above, but in this section

35Sxx Pseudodifferential operators and other generalizations of partial differential operators {For operator theory, see [47G30](#), [58J40](#)}

- 35S05** Pseudodifferential operators as generalizations of partial differential operators [See also [32W25](#), [47G30](#), [47L80](#), [58J40](#)]
- 35S10** Initial value problems for PDEs with pseudodifferential operators
- 35S15** Boundary value problems for PDEs with pseudodifferential operators
- 35S16** Initial-boundary value problems for PDEs with pseudodifferential operators
- 35S30** Fourier integral operators applied to PDEs [See also [43A32](#), [58J40](#)]
- 35S35** Topological aspects for pseudodifferential operators in context of PDEs: intersection cohomology, stratified sets, etc. [See also [32C38](#), [32S40](#), [32S60](#), [58J15](#)]
- 35S50** Paradifferential operators as generalizations of partial differential operators in context of PDEs
- 35S99** None of the above, but in this section

37-XX Dynamical systems and ergodic theory [See also [26A18](#), [28Dxx](#), [34Cxx](#), [34Dxx](#), [35Bxx](#), [46Lxx](#), [58Jxx](#), [70-XX](#)]

- 37-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to dynamical systems and ergodic theory
- 37-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to dynamical systems and ergodic theory
- 37-02** Research exposition (monographs, survey articles) pertaining to dynamical systems and ergodic theory
- 37-03** History of dynamical systems and ergodic theory [Consider also classification numbers pertaining to Section [01](#)]
- 37-04** Software, source code, etc. for problems pertaining to dynamical systems and ergodic theory
- 37-06** Proceedings, conferences, collections, etc. pertaining to dynamical systems and ergodic theory
- 37-11** Research data for problems pertaining to dynamical systems and ergodic theory

37Axx Ergodic theory [See also 28Dxx]

- 37A05** Dynamical aspects of measure-preserving transformations
- 37A10** Dynamical systems involving one-parameter continuous families of measure-preserving transformations
- 37A15** General groups of measure-preserving transformations and dynamical systems [See mainly 22Fxx]
- 37A17** Homogeneous flows [See also 22Fxx]
- 37A20** Algebraic ergodic theory, cocycles, orbit equivalence, ergodic equivalence relations
- 37A25** Ergodicity, mixing, rates of mixing
- 37A30** Ergodic theorems, spectral theory, Markov operators {For operator ergodic theory, see mainly 47A35}
- 37A35** Entropy and other invariants, isomorphism, classification in ergodic theory
- 37A40** Nonsingular (and infinite-measure preserving) transformations
- 37A45** Relations between ergodic theory and number theory [See also 11Kxx]
- 37A46** Relations between ergodic theory and harmonic analysis
- 37A50** Dynamical systems and their relations with probability theory and stochastic processes [See also 60Fxx, 60G10]
- 37A55** Dynamical systems and the theory of C^* -algebras [See mainly 46L55]
- 37A60** Dynamical aspects of statistical mechanics [See also 82Cxx]
- 37A99** None of the above, but in this section

37Bxx Topological dynamics

- 37B02** Dynamics in general topological spaces
- 37B05** Dynamical systems involving transformations and group actions with special properties (minimality, distality, proximality, expansivity, etc.)
- 37B10** Symbolic dynamics
- 37B15** Dynamical aspects of cellular automata {For computational aspects, see 68Q80}
- 37B20** Notions of recurrence and recurrent behavior in dynamical systems
- 37B25** Stability of topological dynamical systems
- 37B30** Index theory for dynamical systems, Morse-Conley indices
- 37B35** Gradient-like and recurrent behavior; isolated (locally maximal) invariant sets; attractors, repellers for topological dynamical systems
- 37B40** Topological entropy
- 37B45** Continua theory in dynamics
- 37B50** Multidimensional shifts of finite type
- 37B52** Tiling dynamics
- 37B55** Topological dynamics of nonautonomous systems
- 37B65** Approximate trajectories, pseudotrajectories, shadowing and related notions for topological dynamical systems
- 37B99** None of the above, but in this section

37Cxx Smooth dynamical systems: general theory [See also [34Cxx](#), [34Dxx](#)]

37C05 Dynamical systems involving smooth mappings and diffeomorphisms

37C10 Dynamics induced by flows and semiflows

37C15 Topological and differentiable equivalence, conjugacy, moduli, classification of dynamical systems

37C20 Generic properties, structural stability of dynamical systems

37C25 Fixed points and periodic points of dynamical systems; fixed-point index theory, local dynamics

37C27 Periodic orbits of vector fields and flows

37C29 Homoclinic and heteroclinic orbits for dynamical systems

37C30 Functional analytic techniques in dynamical systems; zeta functions, (Ruelle-Frobenius) transfer operators, etc.

37C35 Orbit growth in dynamical systems

37C40 Smooth ergodic theory, invariant measures for smooth dynamical systems [See also [37Dxx](#)]

37C45 Dimension theory of smooth dynamical systems

37C50 Approximate trajectories (pseudotrajectories, shadowing, etc.) in smooth dynamics

37C55 Periodic and quasi-periodic flows and diffeomorphisms

37C60 Nonautonomous smooth dynamical systems [See also [37B55](#)]

37C65 Monotone flows as dynamical systems

37C70 Attractors and repellers of smooth dynamical systems and their topological structure

37C75 Stability theory for smooth dynamical systems

37C80 Symmetries and invariants of dynamical systems

37C81 Equivariant dynamical systems

37C83 Dynamical systems with singularities (billiards, etc.)

37C85 Dynamics induced by group actions other than \mathbb{Z} and \mathbb{R} , and \mathbb{C} [See mainly [22Fxx](#), and also [32M25](#), [57R30](#), [57Sxx](#)]

37C86 Foliations generated by dynamical systems

37C99 None of the above, but in this section

37Dxx Dynamical systems with hyperbolic behavior

37D05 Dynamical systems with hyperbolic orbits and sets

37D10 Invariant manifold theory for dynamical systems

37D15 Morse-Smale systems

37D20 Uniformly hyperbolic systems (expanding, Anosov, Axiom A, etc.)

37D25 Nonuniformly hyperbolic systems (Lyapunov exponents, Pesin theory, etc.)

37D30 Partially hyperbolic systems and dominated splittings

37D35 Thermodynamic formalism, variational principles, equilibrium states for dynamical systems

37D40 Dynamical systems of geometric origin and hyperbolicity (geodesic and horocycle flows, etc.)

37D45 Strange attractors, chaotic dynamics of systems with hyperbolic behavior

37D99 None of the above, but in this section

37Exx Low-dimensional dynamical systems

37E05 Dynamical systems involving maps of the interval (piecewise continuous, continuous, smooth)

37E10 Dynamical systems involving maps of the circle

37E15 Combinatorial dynamics (types of periodic orbits)

37E20 Universality and renormalization of dynamical systems [See also [37F25](#)]

37E25 Dynamical systems involving maps of trees and graphs

37E30 Dynamical systems involving homeomorphisms and diffeomorphisms of planes and surfaces

37E35 Flows on surfaces

37E40 Dynamical aspects of twist maps

37E45 Rotation numbers and vectors

37E99 None of the above, but in this section

37Fxx Dynamical systems over complex numbers [See also [30D05](#), [32H50](#)]

37F05 Dynamical systems involving relations and correspondences in one complex variable

37F10 Dynamics of complex polynomials, rational maps, entire and meromorphic functions; Fatou and Julia sets
[See also [32A10](#), [32A20](#), [32H02](#), [32H04](#)]

37F12 Critical orbits for holomorphic dynamical systems

37F15 Expanding holomorphic maps; hyperbolicity; structural stability of holomorphic dynamical systems

37F20 Combinatorics and topology in relation with holomorphic dynamical systems

37F25 Renormalization of holomorphic dynamical systems

37F30 Quasiconformal methods in holomorphic dynamics; quasiconformal dynamics

37F32 Fuchsian and Kleinian groups as dynamical systems

37F34 Teichmüller theory; moduli spaces of holomorphic dynamical systems

37F35 Conformal densities and Hausdorff dimension for holomorphic dynamical systems

37F40 Geometric limits in holomorphic dynamics

37F45 Holomorphic families of dynamical systems; holomorphic motions; semigroups of holomorphic maps

37F46 Bifurcations; parameter spaces in holomorphic dynamics; the Mandelbrot and Multibrot sets

37F50 Small divisors, rotation domains and linearization in holomorphic dynamics

37F75 Dynamical aspects of holomorphic foliations and vector fields [See also [32M25](#), [32S65](#), [34Mxx](#)]

37F80 Higher-dimensional holomorphic and meromorphic dynamics

37F99 None of the above, but in this section

37Gxx Local and nonlocal bifurcation theory for dynamical systems [See also [34C23](#), [34K18](#)]

37G05 Normal forms for dynamical systems

37G10 Bifurcations of singular points in dynamical systems

37G15 Bifurcations of limit cycles and periodic orbits in dynamical systems

37G20 Hyperbolic singular points with homoclinic trajectories in dynamical systems

37G25 Bifurcations connected with nontransversal intersection in dynamical systems

37G30 Infinite nonwandering sets arising in bifurcations of dynamical systems

37G35 Dynamical aspects of attractors and their bifurcations

37G40 Dynamical aspects of symmetries, equivariant bifurcation theory

37G99 None of the above, but in this section

37Hxx Random dynamical systems [See also [15B52](#), [34D08](#), [34F05](#), [47B80](#), [70L05](#), [82C05](#), [93Exx](#)]

37H05 General theory of random and stochastic dynamical systems

37H10 Generation, random and stochastic difference and differential equations [See also [34F05](#), [34K50](#), [60H10](#), [60H15](#)]

37H12 Random iteration

37H15 Random dynamical systems aspects of multiplicative ergodic theory, Lyapunov exponents [See also [34D08](#), [37Axx](#), [37Cxx](#), [37Dxx](#)]

37H20 Bifurcation theory for random and stochastic dynamical systems [See also [37Gxx](#)]

37H30 Stability theory for random and stochastic dynamical systems

37H99 None of the above, but in this section

37Jxx Dynamical aspects of finite-dimensional Hamiltonian and Lagrangian systems [See also [53Dxx](#), [70Fxx](#), [70Hxx](#)]

37J05 General theory of finite-dimensional Hamiltonian and Lagrangian systems, Hamiltonian and Lagrangian structures, symmetries, invariants

37J10 Symplectic and canonical mappings

37J12 Fixed points and periodic points of finite-dimensional Hamiltonian and Lagrangian systems

37J20 Bifurcation problems for finite-dimensional Hamiltonian and Lagrangian systems

37J25 Stability problems for finite-dimensional Hamiltonian and Lagrangian systems

37J30 Obstructions to integrability for finite-dimensional Hamiltonian and Lagrangian systems (nonintegrability criteria)

37J35 Completely integrable finite-dimensional Hamiltonian systems, integration methods, integrability tests

37J37 Relations of finite-dimensional Hamiltonian and Lagrangian systems with Lie algebras and other algebraic structures

- 37J38** Relations of finite-dimensional Hamiltonian and Lagrangian systems with algebraic geometry, complex analysis, special functions
- 37J39** Relations of finite-dimensional Hamiltonian and Lagrangian systems with topology, geometry and differential geometry (symplectic geometry, Poisson geometry, etc.) [See also [53D20](#)]
- 37J40** Perturbations of finite-dimensional Hamiltonian systems, normal forms, small divisors, KAM theory, Arnol'd diffusion
- 37J45** Periodic, homoclinic and heteroclinic orbits of finite-dimensional Hamiltonian systems
- 37J50** Action-minimizing orbits and measures for finite-dimensional Hamiltonian and Lagrangian systems; variational principles; degree-theoretic methods
- 37J55** Contact systems [See also [53D10](#)]
- 37J60** Nonholonomic dynamical systems [See also [70F25](#)]
- 37J65** Nonautonomous Hamiltonian dynamical systems (Painlevé equations, etc.)
- 37J70** Completely integrable discrete dynamical systems
- 37J99** None of the above, but in this section
- 37Kxx** **Dynamical system aspects of infinite-dimensional Hamiltonian and Lagrangian systems** [See also [35Axx](#), [35Qxx](#)]
- 37K05** General theory of infinite-dimensional Hamiltonian and Lagrangian systems, Hamiltonian and Lagrangian structures, symmetries, conservation laws
- 37K10** Completely integrable infinite-dimensional Hamiltonian and Lagrangian systems, integration methods, integrability tests, integrable hierarchies (KdV, KP, Toda, etc.)
- 37K15** Inverse spectral and scattering methods for infinite-dimensional Hamiltonian and Lagrangian systems
- 37K20** Relations of infinite-dimensional Hamiltonian and Lagrangian dynamical systems with algebraic geometry, complex analysis, and special functions [See also [14H70](#)]
- 37K25** Relations of infinite-dimensional Hamiltonian and Lagrangian dynamical systems with topology, geometry and differential geometry
- 37K30** Relations of infinite-dimensional Hamiltonian and Lagrangian dynamical systems with infinite-dimensional Lie algebras and other algebraic structures
- 37K35** Lie-Bäcklund and other transformations for infinite-dimensional Hamiltonian and Lagrangian systems
- 37K40** Soliton theory, asymptotic behavior of solutions of infinite-dimensional Hamiltonian systems
- 37K45** Stability problems for infinite-dimensional Hamiltonian and Lagrangian systems
- 37K50** Bifurcation problems for infinite-dimensional Hamiltonian and Lagrangian systems
- 37K55** Perturbations, KAM for infinite-dimensional Hamiltonian and Lagrangian systems
- 37K58** Variational principles and methods for infinite-dimensional Hamiltonian and Lagrangian systems
- 37K60** Lattice dynamics; integrable lattice equations [See also [37L60](#)]
- 37K99** None of the above, but in this section

37Lxx Infinite-dimensional dissipative dynamical systems [See also [35Bxx](#), [35Qxx](#)]

- 37L05** General theory of infinite-dimensional dissipative dynamical systems, nonlinear semigroups, evolution equations
- 37L10** Normal forms, center manifold theory, bifurcation theory for infinite-dimensional dissipative dynamical systems
- 37L15** Stability problems for infinite-dimensional dissipative dynamical systems
- 37L20** Symmetries of infinite-dimensional dissipative dynamical systems
- 37L25** Inertial manifolds and other invariant attracting sets of infinite-dimensional dissipative dynamical systems
- 37L30** Infinite-dimensional dissipative dynamical systems–attractors and their dimensions, Lyapunov exponents
- 37L40** Invariant measures for infinite-dimensional dissipative dynamical systems
- 37L45** Hyperbolicity; Lyapunov functions for infinite-dimensional dissipative dynamical systems
- 37L50** Noncompact semigroups; dispersive equations; perturbations of infinite-dimensional dissipative dynamical systems
- 37L55** Infinite-dimensional random dynamical systems; stochastic equations [See also [35R60](#), [60H10](#), [60H15](#)]
- 37L60** Lattice dynamics and infinite-dimensional dissipative dynamical systems [See also [37K60](#)]
- 37L65** Special approximation methods (nonlinear Galerkin, etc.) for infinite-dimensional dissipative dynamical systems
- 37L99** None of the above, but in this section

37Mxx Approximation methods and numerical treatment of dynamical systems {For numerical analysis, see also [65Pxx](#); for software etc., see [37-04](#)}

- 37M05** Simulation of dynamical systems
- 37M10** Time series analysis of dynamical systems
- 37M15** Discretization methods and integrators (symplectic, variational, geometric, etc.) for dynamical systems
- 37M20** Computational methods for bifurcation problems in dynamical systems
- 37M21** Computational methods for invariant manifolds of dynamical systems
- 37M22** Computational methods for attractors of dynamical systems
- 37M25** Computational methods for ergodic theory (approximation of invariant measures, computation of Lyapunov exponents, entropy, etc.)
- 37M99** None of the above, but in this section

37Nxx Applications of dynamical systems

- 37N05** Dynamical systems in classical and celestial mechanics [See mainly [70Fxx](#), [70Hxx](#), [70Kxx](#)]
- 37N10** Dynamical systems in fluid mechanics, oceanography and meteorology [See mainly [76-XX](#), especially [76D05](#), [76F20](#), [86A05](#), [86A10](#)]
- 37N15** Dynamical systems in solid mechanics [See mainly [74Hxx](#)]
- 37N20** Dynamical systems in other branches of physics (quantum mechanics, general relativity, laser physics)

- 37N25** Dynamical systems in biology [See also [92-XX](#)]
- 37N30** Dynamical systems in numerical analysis [See also [65-XX](#)]
- 37N35** Dynamical systems in control [See also [93-XX](#)]
- 37N40** Dynamical systems in optimization and economics [See also [90-XX](#), [91-XX](#)]
- 37N99** None of the above, but in this section

37Pxx Arithmetic and non-Archimedean dynamical systems [See also [11S82](#), [37A45](#)]

- 37P05** Arithmetic and non-Archimedean dynamical systems involving polynomial and rational maps
- 37P10** Arithmetic and non-Archimedean dynamical systems involving analytic and meromorphic maps
- 37P15** Dynamical systems over global ground fields
- 37P20** Dynamical systems over non-Archimedean local ground fields
- 37P25** Dynamical systems over finite ground fields
- 37P30** Height functions; Green functions; invariant measures in arithmetic and non-Archimedean dynamical systems [See also [11G50](#), [14G40](#)]
- 37P35** Arithmetic properties of periodic points
- 37P40** Non-Archimedean Fatou and Julia sets
- 37P45** Families and moduli spaces in arithmetic and non-Archimedean dynamical systems
- 37P50** Dynamical systems on Berkovich spaces
- 37P55** Arithmetic dynamics on general algebraic varieties
- 37P99** None of the above, but in this section

39-XX Difference and functional equations

- 39-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to difference and functional equations
- 39-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to difference and functional equations
- 39-02** Research exposition (monographs, survey articles) pertaining to difference and functional equations
- 39-03** History of difference and functional equations [Consider also classification numbers pertaining to [Section 01](#)]
- 39-04** Software, source code, etc. for problems pertaining to difference and functional equations
- 39-06** Proceedings, conferences, collections, etc. pertaining to difference and functional equations
- 39-08** Computational methods for problems pertaining to difference and functional equations
- 39-11** Research data for problems pertaining to difference and functional equations

39Axx Difference equations {For dynamic equations on time scales, see [34N05](#); for dynamical systems, see [37-XX](#)}

39A05 General theory of difference equations

39A06 Linear difference equations

39A10 Additive difference equations

39A12 Discrete version of topics in analysis

39A13 Difference equations, scaling (q -differences) [See also [33Dxx](#)]

39A14 Partial difference equations

39A20 Multiplicative and other generalized difference equations, e.g., of Lyness type

39A21 Oscillation theory for difference equations

39A22 Growth, boundedness, comparison of solutions to difference equations

39A23 Periodic solutions of difference equations

39A24 Almost periodic solutions of difference equations

39A26 Fuzzy difference equations

39A27 Boundary value problems for difference equations

39A28 Bifurcation theory for difference equations

39A30 Stability theory for difference equations

39A33 Chaotic behavior of solutions of difference equations

39A35 Integrable difference and lattice equations; integrability tests

39A45 Difference equations in the complex domain

39A50 Stochastic difference equations

39A60 Applications of difference equations

39A70 Difference operators [See also [47B39](#)]

39A99 None of the above, but in this section

39Bxx Functional equations and inequalities [See also [30D05](#)]

39B05 General theory of functional equations and inequalities

39B12 Iteration theory, iterative and composite equations [See also [26A18](#), [30D05](#), [37-XX](#)]

39B22 Functional equations for real functions [See also [26A51](#), [26B25](#)]

39B32 Functional equations for complex functions [See also [30D05](#)]

39B42 Matrix and operator functional equations [See also [47Jxx](#)]

39B52 Functional equations for functions with more general domains and/or ranges

39B55 Orthogonal additivity and other conditional functional equations

39B62 Functional inequalities, including subadditivity, convexity, etc. [See also [26A51](#), [26B25](#), [26Dxx](#)]

39B72 Systems of functional equations and inequalities

39B82 Stability, separation, extension, and related topics for functional equations [See also [46A22](#)]

39B99 None of the above, but in this section

40-XX Sequences, series, summability

40-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to sequences, series, summability

40-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to sequences, series, summability

40-02 Research exposition (monographs, survey articles) pertaining to sequences, series, summability

40-03 History of sequences, series, summability [Consider also classification numbers pertaining to Section [01](#)]

40-04 Software, source code, etc. for problems pertaining to sequences, series, summability

40-06 Proceedings, conferences, collections, etc. pertaining to sequences, series, summability

40-08 Computational methods for problems pertaining to sequences, series, summability

40-11 Research data for problems pertaining to sequences, series, summability

40Axx Convergence and divergence of infinite limiting processes

40A05 Convergence and divergence of series and sequences

40A10 Convergence and divergence of integrals

40A15 Convergence and divergence of continued fractions [See also [30B70](#)]

40A20 Convergence and divergence of infinite products

40A25 Approximation to limiting values (summation of series, etc.) {For the Euler-Maclaurin summation formula, see [65B15](#)}

40A30 Convergence and divergence of series and sequences of functions

40A35 Ideal and statistical convergence [See also [40G15](#)]

40A99 None of the above, but in this section

40Bxx Multiple sequences and series

40B05 Multiple sequences and series (should also be assigned at least one other classification number in this section)

40B99 None of the above, but in this section

40Cxx General summability methods

40C05 Matrix methods for summability

40C10 Integral methods for summability

40C15 Function-theoretic methods (including power series methods and semicontinuous methods) for summability

40C99 None of the above, but in this section

40Dxx Direct theorems on summability

40D05 General theorems on summability

40D09 Structure of summability fields

40D10 Tauberian constants and oscillation limits in summability theory

40D15 Convergence factors and summability factors

40D20 Summability and bounded fields of methods

40D25 Inclusion and equivalence theorems in summability theory

40D99 None of the above, but in this section

40Exx Inversion theorems

40E05 Tauberian theorems, general

40E10 Growth estimates

40E15 Lacunary inversion theorems

40E20 Tauberian constants

40E99 None of the above, but in this section

40Fxx Absolute and strong summability (should also be assigned at least one other classification number in Section 40)

40F05 Absolute and strong summability (should also be assigned at least one other classification number in Section 40)

40F99 None of the above, but in this section

40Gxx Special methods of summability

40G05 Cesàro, Euler, Nörlund and Hausdorff methods

40G10 Abel, Borel and power series methods

40G15 Summability methods using statistical convergence [See also [40A35](#)]

40G99 None of the above, but in this section

40Hxx Functional analytic methods in summability

40H05 Functional analytic methods in summability

40H99 None of the above, but in this section

40Jxx Summability in abstract structures (should also be assigned at least one other classification number from Section 40) [See also [43A55](#), [46A35](#), [46B15](#)]

40J05 Summability in abstract structures (should also be assigned at least one other classification number from Section 40) [See also [43A55](#), [46A35](#), [46B15](#)]

40J99 None of the above, but in this section

41-XX Approximations and expansions {For approximation theory in the complex domain, see [30E05](#), [30E10](#); for trigonometric approximation and interpolation, see [42A10](#), [42A15](#); for numerical approximation, see [65Dxx](#)}

41-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to approximations and expansions

41-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to approximations and expansions

41-02 Research exposition (monographs, survey articles) pertaining to approximations and expansions

41-03 History of approximations and expansions [Consider also classification numbers pertaining to Section [01](#)]

41-04 Software, source code, etc. for problems pertaining to approximations and expansions

41-06 Proceedings, conferences, collections, etc. pertaining to approximations and expansions

41-11 Research data for problems pertaining to approximations and expansions

41Axx Approximations and expansions {For approximation theory in the complex domain, see [30E05](#), [30E10](#); for trigonometric approximation and interpolation, see [42A10](#), [42A15](#); for numerical approximation, see [65Dxx](#)}

41A05 Interpolation in approximation theory [See also [42A15](#), [65D05](#)]

41A10 Approximation by polynomials {For approximation by trigonometric polynomials, see [42A10](#)}

41A15 Spline approximation

41A17 Inequalities in approximation (Bernstein, Jackson, Nikol'skii-type inequalities)

41A20 Approximation by rational functions

41A21 Padé approximation

41A25 Rate of convergence, degree of approximation

41A27 Inverse theorems in approximation theory

41A28 Simultaneous approximation

41A29 Approximation with constraints

41A30 Approximation by other special function classes

41A35 Approximation by operators (in particular, by integral operators)

41A36 Approximation by positive operators

41A40 Saturation in approximation theory

41A44 Best constants in approximation theory

41A45 Approximation by arbitrary linear expressions

41A46 Approximation by arbitrary nonlinear expressions; widths and entropy

41A50 Best approximation, Chebyshev systems

41A52 Uniqueness of best approximation

- 41A55 Approximate quadratures
- 41A58 Series expansions (e.g., Taylor, Lidstone series, but not Fourier series)
- 41A60 Asymptotic approximations, asymptotic expansions (steepest descent, etc.) [See also 30E15]
- 41A63 Multidimensional problems (should also be assigned at least one other classification number from Section 41)
- 41A65 Abstract approximation theory (approximation in normed linear spaces and other abstract spaces)
- 41A80 Remainders in approximation formulas
- 41A81 Weighted approximation
- 41A99 None of the above, but in this section

42-XX Harmonic analysis on Euclidean spaces

- 42-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to harmonic analysis on Euclidean spaces
- 42-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to harmonic analysis on Euclidean spaces
- 42-02 Research exposition (monographs, survey articles) pertaining to harmonic analysis on Euclidean spaces
- 42-03 History of harmonic analysis on Euclidean spaces [Consider also classification numbers pertaining to Section 01]
- 42-04 Software, source code, etc. for problems pertaining to harmonic analysis on Euclidean spaces
- 42-06 Proceedings, conferences, collections, etc. pertaining to harmonic analysis on Euclidean spaces
- 42-08 Computational methods for problems pertaining to harmonic analysis on Euclidean spaces
- 42-11 Research data for problems pertaining to harmonic analysis on Euclidean spaces

42Axx Harmonic analysis in one variable

- 42A05 Trigonometric polynomials, inequalities, extremal problems
- 42A10 Trigonometric approximation
- 42A15 Trigonometric interpolation
- 42A16 Fourier coefficients, Fourier series of functions with special properties, special Fourier series {For automorphic theory, see mainly 11F30}
- 42A20 Convergence and absolute convergence of Fourier and trigonometric series
- 42A24 Summability and absolute summability of Fourier and trigonometric series
- 42A32 Trigonometric series of special types (positive coefficients, monotonic coefficients, etc.)
- 42A38 Fourier and Fourier-Stieltjes transforms and other transforms of Fourier type
- 42A45 Multipliers in one variable harmonic analysis
- 42A50 Conjugate functions, conjugate series, singular integrals
- 42A55 Lacunary series of trigonometric and other functions; Riesz products

- 42A61 Probabilistic methods for one variable harmonic analysis
- 42A63 Uniqueness of trigonometric expansions, uniqueness of Fourier expansions, Riemann theory, localization
- 42A65 Completeness of sets of functions in one variable harmonic analysis
- 42A70 Trigonometric moment problems in one variable harmonic analysis
- 42A75 Classical almost periodic functions, mean periodic functions [See also [43A60](#)]
- 42A82 Positive definite functions in one variable harmonic analysis
- 42A85 Convolution, factorization for one variable harmonic analysis
- 42A99 None of the above, but in this section

- 42Bxx Harmonic analysis in several variables {For automorphic theory, see mainly [11F30](#)}**
- 42B05 Fourier series and coefficients in several variables
- 42B08 Summability in several variables
- 42B10 Fourier and Fourier-Stieltjes transforms and other transforms of Fourier type
- 42B15 Multipliers for harmonic analysis in several variables
- 42B20 Singular and oscillatory integrals (Calderón-Zygmund, etc.)
- 42B25 Maximal functions, Littlewood-Paley theory
- 42B30 H^p -spaces
- 42B35 Function spaces arising in harmonic analysis
- 42B37 Harmonic analysis and PDEs [See also [35-XX](#)]
- 42B99 None of the above, but in this section

- 42Cxx Nontrigonometric harmonic analysis**
- 42C05 Orthogonal functions and polynomials, general theory of nontrigonometric harmonic analysis [See also [33C45](#), [33C50](#), [33D45](#)]
- 42C10 Fourier series in special orthogonal functions (Legendre polynomials, Walsh functions, etc.)
- 42C15 General harmonic expansions, frames
- 42C20 Other transformations of harmonic type
- 42C25 Uniqueness and localization for orthogonal series
- 42C30 Completeness of sets of functions in nontrigonometric harmonic analysis
- 42C40 Nontrigonometric harmonic analysis involving wavelets and other special systems
- 42C99 None of the above, but in this section

43-XX Abstract harmonic analysis {For other analysis on topological and Lie groups, see [22Exx](#)}

- 43-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to abstract harmonic analysis
- 43-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to abstract harmonic analysis
- 43-02** Research exposition (monographs, survey articles) pertaining to abstract harmonic analysis
- 43-03** History of abstract harmonic analysis [Consider also classification numbers pertaining to [Section 01](#)]
- 43-04** Software, source code, etc. for problems pertaining to abstract harmonic analysis
- 43-06** Proceedings, conferences, collections, etc. pertaining to abstract harmonic analysis
- 43-08** Computational methods for problems pertaining to abstract harmonic analysis
- 43-11** Research data for problems pertaining to abstract harmonic analysis

43Axx Abstract harmonic analysis {For other analysis on topological and Lie groups, see [22Exx](#)}

- 43A05** Measures on groups and semigroups, etc.
- 43A07** Means on groups, semigroups, etc.; amenable groups
- 43A10** Measure algebras on groups, semigroups, etc.
- 43A15** L^p -spaces and other function spaces on groups, semigroups, etc.
- 43A17** Analysis on ordered groups, H^p -theory
- 43A20** L^1 -algebras on groups, semigroups, etc.
- 43A22** Homomorphisms and multipliers of function spaces on groups, semigroups, etc.
- 43A25** Fourier and Fourier-Stieltjes transforms on locally compact and other abelian groups
- 43A30** Fourier and Fourier-Stieltjes transforms on nonabelian groups and on semigroups, etc.
- 43A32** Other transforms and operators of Fourier type
- 43A35** Positive definite functions on groups, semigroups, etc.
- 43A40** Character groups and dual objects
- 43A45** Spectral synthesis on groups, semigroups, etc.
- 43A46** Special sets (thin sets, Kronecker sets, Helson sets, Ditkin sets, Sidon sets, etc.)
- 43A50** Convergence of Fourier series and of inverse transforms
- 43A55** Summability methods on groups, semigroups, etc. [See also [40J05](#)]
- 43A60** Almost periodic functions on groups and semigroups and their generalizations (recurrent functions, distal functions, etc.); almost automorphic functions
- 43A62** Harmonic analysis on hypergroups
- 43A65** Representations of groups, semigroups, etc. (aspects of abstract harmonic analysis) [See also [22A10](#), [22A20](#), [22Dxx](#), [22E45](#)]

- 43A70 Analysis on specific locally compact and other abelian groups [See also [11R56](#), [22B05](#)]
- 43A75 Harmonic analysis on specific compact groups
- 43A77 Harmonic analysis on general compact groups
- 43A80 Analysis on other specific Lie groups [See also [22Exx](#)]
- 43A85 Harmonic analysis on homogeneous spaces
- 43A90 Harmonic analysis and spherical functions [See also [22E45](#), [22E46](#), [33C55](#)]
- 43A95 Categorical methods for abstract harmonic analysis [See also [46Mxx](#)]
- 43A99 None of the above, but in this section

44-XX Integral transforms, operational calculus {For fractional derivatives and integrals, see [26A33](#); for Fourier transforms, see [42A38](#), [42B10](#); for integral transforms in distribution spaces, see [46F12](#); for numerical methods, see [65R10](#)}

- 44-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to integral transforms
- 44-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to integral transforms
- 44-02 Research exposition (monographs, survey articles) pertaining to integral transforms
- 44-03 History of integral transforms [Consider also classification numbers pertaining to Section [01](#)]
- 44-04 Software, source code, etc. for problems pertaining to integral transforms
- 44-06 Proceedings, conferences, collections, etc. pertaining to integral transforms
- 44-11 Research data for problems pertaining to integral transforms

44Axx Integral transforms, operational calculus {For fractional derivatives and integrals, see [26A33](#); for Fourier transforms, see [42A38](#), [42B10](#); for integral transforms in distribution spaces, see [46F12](#); for numerical methods, see [65R10](#)}

- 44A05 General integral transforms [See also [42A38](#)]
- 44A10 Laplace transform
- 44A12 Radon transform [See also [92C55](#)]
- 44A15 Special integral transforms (Legendre, Hilbert, etc.)
- 44A20 Integral transforms of special functions
- 44A30 Multiple integral transforms
- 44A35 Convolution as an integral transform
- 44A40 Calculus of Mikusiński and other operational calculi
- 44A45 Classical operational calculus
- 44A55 Discrete operational calculus
- 44A60 Moment problems {For trigonometric moment problems, see [42A70](#)}
- 44A99 None of the above, but in this section

45-XX Integral equations

45-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to integral equations

45-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to integral equations

45-02 Research exposition (monographs, survey articles) pertaining to integral equations

45-03 History of integral equations [Consider also classification numbers pertaining to Section [01](#)]

45-04 Software, source code, etc. for problems pertaining to integral equations

45-06 Proceedings, conferences, collections, etc. pertaining to integral equations

45-11 Research data for problems pertaining to integral equations

45Axx Linear integral equations

45A05 Linear integral equations

45A99 None of the above, but in this section

45Bxx Fredholm integral equations

45B05 Fredholm integral equations

45B99 None of the above, but in this section

45Cxx Eigenvalue problems for integral equations [See also [34Lxx](#), [35Pxx](#), [45P05](#), [47A75](#)]

45C05 Eigenvalue problems for integral equations [See also [34Lxx](#), [35Pxx](#), [45P05](#), [47A75](#)]

45C99 None of the above, but in this section

45Dxx Volterra integral equations [See also [34A12](#)]

45D05 Volterra integral equations [See also [34A12](#)]

45D99 None of the above, but in this section

45Exx Singular integral equations [See also [30E20](#), [30E25](#), [44A15](#), [44A35](#)]

45E05 Integral equations with kernels of Cauchy type [See also [35J15](#)]

45E10 Integral equations of the convolution type (Abel, Picard, Toeplitz and Wiener-Hopf type) [See also [47B35](#)]

45E99 None of the above, but in this section

45Fxx Systems of linear integral equations

45F05 Systems of nonsingular linear integral equations

45F10 Dual, triple, etc., integral and series equations

45F15 Systems of singular linear integral equations

45F99 None of the above, but in this section

45Gxx Nonlinear integral equations [See also [47H30](#), [47Jxx](#)]

45G05 Singular nonlinear integral equations

45G10 Other nonlinear integral equations

45G15 Systems of nonlinear integral equations

45G99 None of the above, but in this section

45Hxx Integral equations with miscellaneous special kernels [See also [44A15](#)]

45H05 Integral equations with miscellaneous special kernels [See also [44A15](#)]

45H99 None of the above, but in this section

45Jxx Integro-ordinary differential equations [See also [34K05](#), [34K30](#), [47G20](#)]

45J05 Integro-ordinary differential equations [See also [34K05](#), [34K30](#), [47G20](#)]

45J99 None of the above, but in this section

45Kxx Integro-partial differential equations [See also [34K30](#), [35R09](#), [35R10](#), [47G20](#)]

45K05 Integro-partial differential equations [See also [34K30](#), [35R09](#), [35R10](#), [47G20](#)]

45K99 None of the above, but in this section

45Lxx Theoretical approximation of solutions to integral equations {For numerical analysis, see [65Rxx](#)}

45L05 Theoretical approximation of solutions to integral equations {For numerical analysis, see [65Rxx](#)}

45L99 None of the above, but in this section

45Mxx Qualitative behavior of solutions to integral equations

45M05 Asymptotics of solutions to integral equations

45M10 Stability theory for integral equations

45M15 Periodic solutions of integral equations

45M20 Positive solutions of integral equations

45M99 None of the above, but in this section

45Nxx Abstract integral equations, integral equations in abstract spaces

45N05 Abstract integral equations, integral equations in abstract spaces

45N99 None of the above, but in this section

45Pxx Integral operators [See also [47B38](#), [47G10](#)]

45P05 Integral operators [See also [47B38](#), [47G10](#)]

45P99 None of the above, but in this section

45Qxx Inverse problems for integral equations

45Q05 Inverse problems for integral equations

45Q99 None of the above, but in this section

45Rxx Random integral equations [See also [60H20](#)]

45R05 Random integral equations [See also [60H20](#)]

45R99 None of the above, but in this section

46-XX Functional analysis {For manifolds modeled on topological linear spaces, see [57Nxx](#), [58Bxx](#)}

46-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to functional analysis

46-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to functional analysis

46-02 Research exposition (monographs, survey articles) pertaining to functional analysis

46-03 History of functional analysis [Consider also classification numbers pertaining to Section [01](#)]

46-04 Software, source code, etc. for problems pertaining to functional analysis

46-06 Proceedings, conferences, collections, etc. pertaining to functional analysis

46-08 Computational methods for problems pertaining to functional analysis

46-11 Research data for problems pertaining to functional analysis

46Axx Topological linear spaces and related structures {For function spaces, see [46Exx](#)}

46A03 General theory of locally convex spaces

46A04 Locally convex Fréchet spaces and (DF)-spaces

46A08 Barrelled spaces, bornological spaces

46A11 Spaces determined by compactness or summability properties (nuclear spaces, Schwartz spaces, Montel spaces, etc.)

46A13 Spaces defined by inductive or projective limits (LB, LF, etc.) [See also [46M40](#)]

46A16 Not locally convex spaces (metrizable topological linear spaces, locally bounded spaces, quasi-Banach spaces, etc.)

46A17 Bornologies and related structures; Mackey convergence, etc.

46A19 Other “topological” linear spaces (convergence spaces, ranked spaces, spaces with a metric taking values in an ordered structure more general than \mathbb{R} , etc.)

46A20 Duality theory for topological vector spaces

46A22 Theorems of Hahn-Banach type; extension and lifting of functionals and operators [See also [46M10](#)]

46A25 Reflexivity and semi-reflexivity [See also [46B10](#)]

46A30 Open mapping and closed graph theorems; completeness (including B -, B_r -completeness)

- 46A32** Spaces of linear operators; topological tensor products; approximation properties [See also [46B28](#), [46M05](#), [47L05](#), [47L20](#)]
- 46A35** Summability and bases in topological vector spaces [See also [46B15](#)]
- 46A40** Ordered topological linear spaces, vector lattices [See also [06F20](#), [46B40](#), [46B42](#)]
- 46A45** Sequence spaces (including Köthe sequence spaces) [See also [46B45](#)]
- 46A50** Compactness in topological linear spaces; angelic spaces, etc.
- 46A55** Convex sets in topological linear spaces; Choquet theory [See also [52A07](#)]
- 46A61** Graded Fréchet spaces and tame operators
- 46A63** Topological invariants ((DN), (Ω) , etc.) for locally convex spaces
- 46A70** Saks spaces and their duals (strict topologies, mixed topologies, two-norm spaces, co-Saks spaces, etc.)
- 46A80** Modular spaces
- 46A99** None of the above, but in this section
- 46Bxx Normed linear spaces and Banach spaces; Banach lattices {For function spaces, see [46Exx](#)}**
- 46B03** Isomorphic theory (including renorming) of Banach spaces
- 46B04** Isometric theory of Banach spaces
- 46B06** Asymptotic theory of Banach spaces [See also [52A23](#)]
- 46B07** Local theory of Banach spaces
- 46B08** Ultraproduct techniques in Banach space theory [See also [46M07](#)]
- 46B09** Probabilistic methods in Banach space theory [See also [60Bxx](#)]
- 46B10** Duality and reflexivity in normed linear and Banach spaces [See also [46A25](#)]
- 46B15** Summability and bases; functional analytic aspects of frames in Banach and Hilbert spaces [See also [46A35](#), [42C15](#)]
- 46B20** Geometry and structure of normed linear spaces
- 46B22** Radon-Nikodým, Kreĭn-Milman and related properties [See also [46G10](#)]
- 46B25** Classical Banach spaces in the general theory
- 46B26** Nonseparable Banach spaces
- 46B28** Spaces of operators; tensor products; approximation properties [See also [46A32](#), [46M05](#), [47L05](#), [47L20](#)]
- 46B40** Ordered normed spaces [See also [46A40](#), [46B42](#)]
- 46B42** Banach lattices [See also [46A40](#), [46B40](#)]
- 46B45** Banach sequence spaces [See also [46A45](#)]
- 46B50** Compactness in Banach (or normed) spaces
- 46B70** Interpolation between normed linear spaces [See also [46M35](#)]
- 46B80** Nonlinear classification of Banach spaces; nonlinear quotients

- 46B85** Embeddings of discrete metric spaces into Banach spaces; applications in topology and computer science [See also [05C12](#), [68Rxx](#)]
- 46B87** Lineability in functional analysis [See also [15A03](#)]
- 46B99** None of the above, but in this section
- 46Cxx Inner product spaces and their generalizations, Hilbert spaces {For function spaces, see [46Exx](#)}**
- 46C05** Hilbert and pre-Hilbert spaces: geometry and topology (including spaces with semidefinite inner product)
- 46C07** Hilbert subspaces (= operator ranges); complementation (Aronszajn, de Branges, etc.) [See also [46B70](#), [46M35](#)]
- 46C15** Characterizations of Hilbert spaces
- 46C20** Spaces with indefinite inner product (Kreĭn spaces, Pontryagin spaces, etc.) [See also [47B50](#)]
- 46C50** Generalizations of inner products (semi-inner products, partial inner products, etc.)
- 46C99** None of the above, but in this section
- 46Exx Linear function spaces and their duals [See also [30H05](#), [32A38](#), [46F05](#)] {For function algebras, see [46J10](#)}**
- 46E05** Lattices of continuous, differentiable or analytic functions
- 46E10** Topological linear spaces of continuous, differentiable or analytic functions
- 46E15** Banach spaces of continuous, differentiable or analytic functions
- 46E20** Hilbert spaces of continuous, differentiable or analytic functions
- 46E22** Hilbert spaces with reproducing kernels (= (proper) functional Hilbert spaces, including de Branges-Rovnyak and other structured spaces) [See also [47B32](#)]
- 46E25** Rings and algebras of continuous, differentiable or analytic functions {For Banach function algebras, see [46J10](#), [46J15](#)}
- 46E27** Spaces of measures [See also [28A33](#), [46Gxx](#)]
- 46E30** Spaces of measurable functions (L^p -spaces, Orlicz spaces, Köthe function spaces, Lorentz spaces, rearrangement invariant spaces, ideal spaces, etc.)
- 46E35** Sobolev spaces and other spaces of “smooth” functions, embedding theorems, trace theorems
- 46E36** Sobolev (and similar kinds of) spaces of functions on metric spaces; analysis on metric spaces
- 46E39** Sobolev (and similar kinds of) spaces of functions of discrete variables
- 46E40** Spaces of vector- and operator-valued functions
- 46E50** Spaces of differentiable or holomorphic functions on infinite-dimensional spaces [See also [46G20](#), [46G25](#), [47H60](#)]
- 46E99** None of the above, but in this section

46Fxx Distributions, generalized functions, distribution spaces [See also [46T30](#)]

46F05 Topological linear spaces of test functions, distributions and ultradistributions [See also [46E10](#), [46E35](#)]

46F10 Operations with distributions and generalized functions

46F12 Integral transforms in distribution spaces [See also [42-XX](#), [44-XX](#)]

46F15 Hyperfunctions, analytic functionals [See also [32A25](#), [32A45](#), [32C35](#), [58J15](#)]

46F20 Distributions and ultradistributions as boundary values of analytic functions [See also [30D40](#), [30E25](#), [32A40](#)]

46F25 Distributions on infinite-dimensional spaces [See also [58C35](#)]

46F30 Generalized functions for nonlinear analysis (Rosinger, Colombeau, nonstandard, etc.)

46F99 None of the above, but in this section

46Gxx Measures, integration, derivative, holomorphy (all involving infinite-dimensional spaces) [See also [28-XX](#), [46Txx](#)]

46G05 Derivatives of functions in infinite-dimensional spaces [See also [46T20](#), [58C20](#), [58C25](#)]

46G10 Vector-valued measures and integration [See also [28Bxx](#), [46B22](#)]

46G12 Measures and integration on abstract linear spaces [See also [28C20](#), [46T12](#)]

46G15 Functional analytic lifting theory [See also [28A51](#)]

46G20 Infinite-dimensional holomorphy [See also [32-XX](#), [46E50](#), [46T25](#), [58B12](#), [58C10](#)]

46G25 (Spaces of) multilinear mappings, polynomials [See also [46E50](#), [46G20](#), [47H60](#)]

46G99 None of the above, but in this section

46Hxx Topological algebras, normed rings and algebras, Banach algebras {For group algebras, convolution algebras and measure algebras, see [43A10](#), [43A20](#)}

46H05 General theory of topological algebras

46H10 Ideals and subalgebras

46H15 Representations of topological algebras

46H20 Structure, classification of topological algebras

46H25 Normed modules and Banach modules, topological modules (if not placed in [13-XX](#) or [16-XX](#))

46H30 Functional calculus in topological algebras [See also [47A60](#)]

46H35 Topological algebras of operators [See mainly [47Lxx](#)]

46H40 Automatic continuity

46H70 Nonassociative topological algebras [See also [46K70](#), [46L70](#)]

46H99 None of the above, but in this section

46Jxx Commutative Banach algebras and commutative topological algebras [See also [46E25](#)]

46J05 General theory of commutative topological algebras

46J10 Banach algebras of continuous functions, function algebras [See also [46E25](#)]

46J15 Banach algebras of differentiable or analytic functions, H^p -spaces [See also [30H10](#), [32A35](#), [32A37](#), [32A38](#), [42B30](#)]

46J20 Ideals, maximal ideals, boundaries

46J25 Representations of commutative topological algebras

46J30 Subalgebras of commutative topological algebras

46J40 Structure and classification of commutative topological algebras

46J45 Radical Banach algebras

46J99 None of the above, but in this section

46Kxx Topological (rings and) algebras with an involution [See also [16W10](#)]

46K05 General theory of topological algebras with involution

46K10 Representations of topological algebras with involution

46K15 Hilbert algebras

46K50 Nonselfadjoint (sub)algebras in algebras with involution

46K70 Nonassociative topological algebras with an involution [See also [46H70](#), [46L70](#)]

46K99 None of the above, but in this section

46Lxx Selfadjoint operator algebras (C^* -algebras, von Neumann (W^* -) algebras, etc.) [See also [22D25](#), [47Lxx](#)]

46L05 General theory of C^* -algebras

46L06 Tensor products of C^* -algebras

46L07 Operator spaces and completely bounded maps [See also [47L25](#)]

46L08 C^* -modules

46L09 Free products of C^* -algebras

46L10 General theory of von Neumann algebras

46L30 States of selfadjoint operator algebras

46L35 Classifications of C^* -algebras

46L36 Classification of factors

46L37 Subfactors and their classification

46L40 Automorphisms of selfadjoint operator algebras

46L45 Decomposition theory for C^* -algebras

- 46L51 Noncommutative measure and integration
- 46L52 Noncommutative function spaces
- 46L53 Noncommutative probability and statistics
- 46L54 Free probability and free operator algebras
- 46L55 Noncommutative dynamical systems [See also 28Dxx, 37Kxx, 37Lxx, 37A55]
- 46L57 Derivations, dissipations and positive semigroups in C^* -algebras
- 46L60 Applications of selfadjoint operator algebras to physics [See also 46N50, 46N55, 47L90, 81T05, 82B10, 82C10]
- 46L65 Quantizations, deformations for selfadjoint operator algebras
- 46L67 Quantum groups (operator algebraic aspects)
- 46L70 Nonassociative selfadjoint operator algebras [See also 46H70, 46K70]
- 46L80 K -theory and operator algebras (including cyclic theory) [See also 18F25, 19Kxx, 46M20, 55Rxx, 58J22]
- 46L85 Noncommutative topology [See also 58B32, 58B34, 58J22]
- 46L87 Noncommutative differential geometry [See also 58B32, 58B34, 58J22]
- 46L89 Other “noncommutative” mathematics based on C^* -algebra theory [See also 58B32, 58B34, 58J22]
- 46L99 None of the above, but in this section

46Mxx Methods of category theory in functional analysis [See also 18-XX]

- 46M05 Tensor products in functional analysis [See also 46A32, 46B28, 47A80]
- 46M07 Ultraproducts in functional analysis [See also 46B08, 46S20]
- 46M10 Projective and injective objects in functional analysis [See also 46A22]
- 46M15 Categories, functors in functional analysis {For K -theory, Ext, etc., see 19K33, 46L80, 46M18, 46M20}
- 46M18 Homological methods in functional analysis (exact sequences, right inverses, lifting, etc.)
- 46M20 Methods of algebraic topology in functional analysis (cohomology, sheaf and bundle theory, etc.) [See also 14F06, 18Fxx, 19Kxx, 32Cxx, 32Lxx, 46L80, 46M15, 46M18, 55Rxx]
- 46M35 Abstract interpolation of topological vector spaces [See also 46B70]
- 46M40 Inductive and projective limits in functional analysis [See also 46A13]
- 46M99 None of the above, but in this section

46Nxx Miscellaneous applications of functional analysis [See also 47Nxx]

- 46N10 Applications of functional analysis in optimization, convex analysis, mathematical programming, economics
- 46N20 Applications of functional analysis to differential and integral equations
- 46N30 Applications of functional analysis in probability theory and statistics
- 46N40 Applications of functional analysis in numerical analysis [See also 65Jxx]
- 46N50 Applications of functional analysis in quantum physics
- 46N55 Applications of functional analysis in statistical physics
- 46N60 Applications of functional analysis in biology and other sciences
- 46N99 None of the above, but in this section

46Sxx Other (nonclassical) types of functional analysis [See also 47Sxx]

46S05 Quaternionic functional analysis

46S10 Functional analysis over fields other than \mathbb{R} or \mathbb{C} or the quaternions; non-Archimedean functional analysis
[See also [12J25](#), [32P05](#)]

46S20 Nonstandard functional analysis [See also [03H05](#)]

46S30 Constructive functional analysis [See also [03F60](#)]

46S40 Fuzzy functional analysis [See also [03E72](#)]

46S50 Functional analysis in probabilistic metric linear spaces

46S60 Functional analysis on superspaces (supermanifolds) or graded spaces [See also [58A50](#), [58C50](#)]

46S99 None of the above, but in this section

46Txx Nonlinear functional analysis [See also 47Hxx, 47Jxx, 58Cxx, 58Dxx]

46T05 Infinite-dimensional manifolds [See also [53Axx](#), [57N20](#), [58Bxx](#), [58Dxx](#)]

46T10 Manifolds of mappings

46T12 Measure (Gaussian, cylindrical, etc.) and integrals (Feynman, path, Fresnel, etc.) on manifolds [See also [28Cxx](#), [46G12](#), [60-XX](#)]

46T20 Continuous and differentiable maps in nonlinear functional analysis [See also [46G05](#)]

46T25 Holomorphic maps in nonlinear functional analysis [See also [46G20](#)]

46T30 Distributions and generalized functions on nonlinear spaces [See also [46Fxx](#)]

46T99 None of the above, but in this section

47-XX Operator theory

47-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to operator theory

47-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to operator theory

47-02 Research exposition (monographs, survey articles) pertaining to operator theory

47-03 History of operator theory [Consider also classification numbers pertaining to [Section 01](#)]

47-04 Software, source code, etc. for problems pertaining to operator theory

47-06 Proceedings, conferences, collections, etc. pertaining to operator theory

47-08 Computational methods for problems pertaining to operator theory

47-11 Research data for problems pertaining to operator theory

47Axx General theory of linear operators

- 47A05 General (adjoints, conjugates, products, inverses, domains, ranges, etc.)
- 47A06 Linear relations (multivalued linear operators)
- 47A07 Forms (bilinear, sesquilinear, multilinear)
- 47A08 Operator matrices [See also [47A13](#)]
- 47A10 Spectrum, resolvent
- 47A11 Local spectral properties of linear operators
- 47A12 Numerical range, numerical radius
- 47A13 Several-variable operator theory (spectral, Fredholm, etc.)
- 47A15 Invariant subspaces of linear operators [See also [47A46](#)]
- 47A16 Cyclic vectors, hypercyclic and chaotic operators
- 47A20 Dilations, extensions, compressions of linear operators
- 47A25 Spectral sets of linear operators
- 47A30 Norms (inequalities, more than one norm, etc.) of linear operators
- 47A35 Ergodic theory of linear operators [See also [28Dxx](#), [37Axx](#)]
- 47A40 Scattering theory of linear operators [See also [34L25](#), [35P25](#), [37K15](#), [58J50](#), [81Uxx](#)]
- 47A45 Canonical models for contractions and nonselfadjoint linear operators
- 47A46 Chains (nests) of projections or of invariant subspaces, integrals along chains, etc.
- 47A48 Operator colligations (= nodes), vessels, linear systems, characteristic functions, realizations, etc.
- 47A50 Equations and inequalities involving linear operators, with vector unknowns
- 47A52 Linear operators and ill-posed problems, regularization [See also [35R25](#), [47J06](#), [65F22](#), [65J20](#), [65L08](#), [65M30](#), [65R30](#)]
- 47A53 (Semi-) Fredholm operators; index theories [See also [58B15](#), [58J20](#)]
- 47A55 Perturbation theory of linear operators [See also [47H14](#), [58J37](#), [70H09](#), [81Q15](#)]
- 47A56 Functions whose values are linear operators (operator- and matrix-valued functions, etc., including analytic and meromorphic ones)
- 47A57 Linear operator methods in interpolation, moment and extension problems [See also [30E05](#), [42A70](#), [42A82](#), [44A60](#)]
- 47A58 Linear operator approximation theory
- 47A60 Functional calculus for linear operators
- 47A62 Equations involving linear operators, with operator unknowns
- 47A63 Linear operator inequalities
- 47A64 Operator means involving linear operators, shorted linear operators, etc.
- 47A65 Structure theory of linear operators

- 47A66 Quasitriangular and nonquasitriangular, quasideagonal and nonquasideagonal linear operators
- 47A67 Representation theory of linear operators
- 47A68 Factorization theory (including Wiener-Hopf and spectral factorizations) of linear operators
- 47A70 (Generalized) eigenfunction expansions of linear operators; rigged Hilbert spaces
- 47A75 Eigenvalue problems for linear operators [See also [47J10](#), [49R05](#)]
- 47A80 Tensor products of linear operators [See also [46M05](#)]
- 47A99 None of the above, but in this section

47Bxx Special classes of linear operators

- 47B01 Operators on Banach spaces
- 47B02 Operators on Hilbert spaces (general)
- 47B06 Riesz operators; eigenvalue distributions; approximation numbers, s -numbers, Kolmogorov numbers, entropy numbers, etc. of operators
- 47B07 Linear operators defined by compactness properties
- 47B10 Linear operators belonging to operator ideals (nuclear, p -summing, in the Schatten-von Neumann classes, etc.) [See also [47L20](#)]
- 47B12 Sectorial operators
- 47B13 Cowen-Douglas operators
- 47B15 Hermitian and normal operators (spectral measures, functional calculus, etc.)
- 47B20 Subnormal operators, hyponormal operators, etc.
- 47B25 Linear symmetric and selfadjoint operators (unbounded)
- 47B28 Nonselfadjoint operators [See also [47A45](#), [81Q12](#)]
- 47B32 Linear operators in reproducing-kernel Hilbert spaces (including de Branges, de Branges-Rovnyak, and other structured spaces) [See also [46E22](#)]
- 47B33 Linear composition operators
- 47B34 Kernel operators
- 47B35 Toeplitz operators, Hankel operators, Wiener-Hopf operators {For other integral operators, see also [45P05](#), [47G10](#)} [See also [32A25](#), [32M15](#)]
- 47B36 Jacobi (tridiagonal) operators (matrices) and generalizations
- 47B37 Linear operators on special spaces (weighted shifts, operators on sequence spaces, etc.)
- 47B38 Linear operators on function spaces (general)
- 47B39 Linear difference operators [See also [39A70](#)]
- 47B40 Spectral operators, decomposable operators, well-bounded operators, etc.
- 47B44 Linear accretive operators, dissipative operators, etc.
- 47B47 Commutators, derivations, elementary operators, etc.

- 47B48 Linear operators on Banach algebras
- 47B49 Transformers, preservers (linear operators on spaces of linear operators)
- 47B50 Linear operators on spaces with an indefinite metric [See also 46C20]
- 47B60 Linear operators on ordered spaces
- 47B65 Positive linear operators and order-bounded operators
- 47B80 Random linear operators [See also 47H40, 60H25]
- 47B90 Operator theory and harmonic analysis [See also 42-XX, 43-XX, 44-XX]
- 47B91 Operators on complex function spaces
- 47B92 Operators on real function spaces
- 47B93 Operators arising in mathematical physics
- 47B99 None of the above, but in this section

47Cxx Individual linear operators as elements of algebraic systems

- 47C05 Linear operators in algebras
- 47C10 Linear operators in *-algebras
- 47C15 Linear operators in C^* - or von Neumann algebras
- 47C99 None of the above, but in this section

47Dxx Groups and semigroups of linear operators, their generalizations and applications

- 47D03 Groups and semigroups of linear operators [See also 20M20] {For nonlinear operators, see 47H20}
- 47D06 One-parameter semigroups and linear evolution equations [See also 34G10, 34K30]
- 47D07 Markov semigroups and applications to diffusion processes {For Markov processes, see 60Jxx}
- 47D08 Schrödinger and Feynman-Kac semigroups
- 47D09 Operator sine and cosine functions and higher-order Cauchy problems [See also 34G10]
- 47D60 C -semigroups, regularized semigroups
- 47D62 Integrated semigroups
- 47D99 None of the above, but in this section

47Exx Ordinary differential operators [See also 34Bxx, 34Lxx]

- 47E05 Ordinary differential operators (should also be assigned at least one other classification number in Section 47) [See also 34Bxx, 34Lxx]
- 47E07 Functional-differential and differential-difference operators [See also 34K08]
- 47E99 None of the above, but in this section

47Fxx Partial differential operators [See also [35Pxx](#), [58Jxx](#)]

47F05 Partial differential operators (should also be assigned at least one other classification number in Section 47)
[See also [35Pxx](#), [58Jxx](#)]

47F10 Elliptic operators and their generalizations {For elliptic complexes, see [58J10](#)}

47F99 None of the above, but in this section

47Gxx Integral, integro-differential, and pseudodifferential operators [See also [58Jxx](#)]

47G10 Integral operators [See also [45P05](#)]

47G20 Integro-differential operators [See also [34K30](#), [35R09](#), [35R10](#), [45Jxx](#), [45Kxx](#)]

47G30 Pseudodifferential operators [See also [35Sxx](#), [58Jxx](#)]

47G40 Potential operators [See also [31-XX](#)]

47G99 None of the above, but in this section

47Hxx Nonlinear operators and their properties {For global and geometric aspects, see [49J53](#), [58-XX](#), especially [58Cxx](#)}

47H04 Set-valued operators [See also [28B20](#), [54C60](#), [58C06](#)]

47H05 Monotone operators and generalizations

47H06 Nonlinear accretive operators, dissipative operators, etc.

47H07 Monotone and positive operators on ordered Banach spaces or other ordered topological vector spaces

47H08 Measures of noncompactness and condensing mappings, K -set contractions, etc.

47H09 Contraction-type mappings, nonexpansive mappings, A -proper mappings, etc.

47H10 Fixed-point theorems [See also [37C25](#), [54H25](#), [55M20](#), [58C30](#)]

47H11 Degree theory for nonlinear operators [See also [55M25](#), [58C30](#)]

47H14 Perturbations of nonlinear operators [See also [47A55](#), [58J37](#), [70H09](#), [70K60](#), [81Q15](#)]

47H20 Semigroups of nonlinear operators [See also [37L05](#), [47J35](#), [54H15](#), [58D07](#)]

47H25 Nonlinear ergodic theorems [See also [28Dxx](#), [37Axx](#), [47A35](#)]

47H30 Particular nonlinear operators (superposition, Hammerstein, Nemytskiĭ, Uryson, etc.) [See also [45Gxx](#), [45P05](#)]

47H40 Random nonlinear operators [See also [47B80](#), [60H25](#)]

47H60 Multilinear and polynomial operators [See also [46G25](#)]

47H99 None of the above, but in this section

47Jxx Equations and inequalities involving nonlinear operators [See also 46Txx] {For global and geometric aspects, see 58-XX}

47J05 Equations involving nonlinear operators (general) [See also 47H10, 47J25]

47J06 Nonlinear ill-posed problems [See also 35R25, 47A52, 65F22, 65J20, 65L08, 65M30, 65R30]

47J07 Abstract inverse mapping and implicit function theorems involving nonlinear operators [See also 46T20, 58C15]

47J10 Nonlinear spectral theory, nonlinear eigenvalue problems [See also 49R05]

47J15 Abstract bifurcation theory involving nonlinear operators [See also 34C23, 37Gxx, 58E07, 58E09]

47J20 Variational and other types of inequalities involving nonlinear operators (general) [See also 49J40]

47J22 Variational and other types of inclusions [See also 34A60, 49J21, 49K21]

47J25 Iterative procedures involving nonlinear operators [See also 47J26, 65J15]

47J26 Fixed-point iterations [See also 47J25]

47J30 Variational methods involving nonlinear operators [See also 58Exx]

47J35 Nonlinear evolution equations [See also 34G20, 35K90, 35L90, 35Qxx, 35R20, 37Kxx, 37Lxx, 47H20, 58D25]

47J40 Equations with nonlinear hysteresis operators [See also 34C55, 74N30]

47J99 None of the above, but in this section

47Lxx Linear spaces and algebras of operators [See also 46Lxx]

47L05 Linear spaces of operators [See also 46A32, 46B28]

47L07 Convex sets and cones of operators [See also 46A55]

47L10 Algebras of operators on Banach spaces and other topological linear spaces

47L15 Operator algebras with symbol structure

47L20 Operator ideals [See also 47B10]

47L22 Ideals of polynomials and of multilinear mappings in operator theory

47L25 Operator spaces (= matricially normed spaces) [See also 46L07]

47L30 Abstract operator algebras on Hilbert spaces

47L35 Nest algebras, CSL algebras

47L40 Limit algebras, subalgebras of C^* -algebras

47L45 Dual algebras; weakly closed singly generated operator algebras

47L50 Dual spaces of operator algebras

47L55 Representations of (nonselfadjoint) operator algebras

47L60 Algebras of unbounded operators; partial algebras of operators

47L65 Crossed product algebras (analytic crossed products)

47L70 Nonassociative nonselfadjoint operator algebras

47L75 Other nonselfadjoint operator algebras

47L80 Algebras of specific types of operators (Toeplitz, integral, pseudodifferential, etc.)

47L90 Applications of operator algebras to the sciences

47L99 None of the above, but in this section

47Nxx **Miscellaneous applications of operator theory** [See also [46Nxx](#)]

47N10 Applications of operator theory in optimization, convex analysis, mathematical programming, economics

47N20 Applications of operator theory to differential and integral equations

47N30 Applications of operator theory in probability theory and statistics

47N40 Applications of operator theory in numerical analysis [See also [65Jxx](#)]

47N50 Applications of operator theory in the physical sciences

47N60 Applications of operator theory in chemistry and life sciences

47N70 Applications of operator theory in systems, signals, circuits, and control theory

47N99 None of the above, but in this section

47Sxx **Other (nonclassical) types of operator theory** [See also [46Sxx](#)]

47S05 Quaternionic operator theory

47S10 Operator theory over fields other than \mathbb{R} , \mathbb{C} or the quaternions; non-Archimedean operator theory

47S20 Nonstandard operator theory [See also [03H05](#)]

47S30 Constructive operator theory [See also [03F60](#)]

47S40 Fuzzy operator theory [See also [03E72](#)]

47S50 Operator theory in probabilistic metric linear spaces [See also [54E70](#)]

47S99 None of the above, but in this section

49-XX **Calculus of variations and optimal control; optimization** [See also [34H05](#), [34K35](#), [65Kxx](#), [90Cxx](#), [93-XX](#)]

49-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to calculus of variations and optimal control

49-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to calculus of variations and optimal control

49-02 Research exposition (monographs, survey articles) pertaining to calculus of variations and optimal control

49-03 History of calculus of variations and optimal control [Consider also classification numbers pertaining to Section [01](#)]

49-04 Software, source code, etc. for problems pertaining to calculus of variations and optimal control

49-06 Proceedings, conferences, collections, etc. pertaining to calculus of variations and optimal control

49-11 Research data for problems pertaining to calculus of variations and optimal control

49Jxx Existence theories in calculus of variations and optimal control

- 49J05** Existence theories for free problems in one independent variable
- 49J10** Existence theories for free problems in two or more independent variables
- 49J15** Existence theories for optimal control problems involving ordinary differential equations
- 49J20** Existence theories for optimal control problems involving partial differential equations
- 49J21** Existence theories for optimal control problems involving relations other than differential equations
- 49J27** Existence theories for problems in abstract spaces [See also [90C48](#), [93C25](#)]
- 49J30** Existence of optimal solutions belonging to restricted classes (Lipschitz controls, bang-bang controls, etc.)
- 49J35** Existence of solutions for minimax problems
- 49J40** Variational inequalities [See also [47J20](#)]
- 49J45** Methods involving semicontinuity and convergence; relaxation
- 49J50** Fréchet and Gateaux differentiability in optimization [See also [46G05](#), [58C20](#)]
- 49J52** Nonsmooth analysis [See also [46G05](#), [58C50](#), [90C56](#)]
- 49J53** Set-valued and variational analysis [See also [28B20](#), [47H04](#), [54C60](#), [58C06](#)]
- 49J55** Existence of optimal solutions to problems involving randomness [See also [93E20](#)]
- 49J99** None of the above, but in this section

49Kxx Optimality conditions

- 49K05** Optimality conditions for free problems in one independent variable
- 49K10** Optimality conditions for free problems in two or more independent variables
- 49K15** Optimality conditions for problems involving ordinary differential equations
- 49K20** Optimality conditions for problems involving partial differential equations
- 49K21** Optimality conditions for problems involving relations other than differential equations
- 49K27** Optimality conditions for problems in abstract spaces [See also [90C48](#), [93C25](#)]
- 49K30** Optimality conditions for solutions belonging to restricted classes (Lipschitz controls, bang-bang controls, etc.)
- 49K35** Optimality conditions for minimax problems
- 49K40** Sensitivity, stability, well-posedness [See also [90C31](#)]
- 49K45** Optimality conditions for problems involving randomness [See also [93E20](#)]
- 49K99** None of the above, but in this section

49Lxx Hamilton-Jacobi theories [See also [70H20](#), [35F21](#)]

- 49L05** Hamilton-Jacobi equations in optimal control and differential games
- 49L20** Dynamic programming in optimal control and differential games
- 49L25** Viscosity solutions to Hamilton-Jacobi equations in optimal control and differential games
- 49L99** None of the above, but in this section

49Mxx Numerical methods in optimal control [See also [65Kxx](#), [90-08](#), [90Cxx](#)]

49M05 Numerical methods based on necessary conditions

49M15 Newton-type methods [See also [90C53](#)]

49M20 Numerical methods of relaxation type

49M25 Discrete approximations in optimal control

49M27 Decomposition methods

49M29 Numerical methods involving duality

49M37 Numerical methods based on nonlinear programming [See also [65Kxx](#), [90C30](#)]

49M40 PDE constrained optimization

49M99 None of the above, but in this section

49Nxx Miscellaneous topics in calculus of variations and optimal control

49N05 Linear optimal control problems [See also [93C05](#)]

49N10 Linear-quadratic optimal control problems

49N15 Duality theory (optimization) [See also [90C46](#)]

49N20 Periodic optimal control problems

49N25 Impulsive optimal control problems

49N30 Problems with incomplete information (optimization) [See also [93C41](#)]

49N35 Optimal feedback synthesis [See also [93B52](#)]

49N45 Inverse problems in optimal control

49N60 Regularity of solutions in optimal control

49N70 Differential games and control [See also [91A23](#)]

49N75 Pursuit and evasion games [See also [91A24](#)]

49N80 Mean field games and control [See also [91A16](#)]

49N90 Applications of optimal control and differential games [See also [90C90](#), [91A80](#), [93C95](#)]

49N99 None of the above, but in this section

49Qxx Manifolds and measure-geometric topics [See also [58Exx](#)]

49Q05 Minimal surfaces and optimization [See also [53A10](#), [58E12](#)]

49Q10 Optimization of shapes other than minimal surfaces [See also [90C90](#)]

49Q12 Sensitivity analysis for optimization problems on manifolds

49Q15 Geometric measure and integration theory, integral and normal currents in optimization [See also [28A75](#), [32C30](#), [58A25](#), [58C35](#)]

49Q20 Variational problems in a geometric measure-theoretic setting

49Q25 Optimal transportation [See also [90B06](#)]

49Q99 None of the above, but in this section

49Rxx Variational methods for eigenvalues of operators (should also be assigned at least one other classification number in Section 49) [See also 47A75]

49R05 Variational methods for eigenvalues of operators (should also be assigned at least one other classification number in Section 49) [See also 47A75]

49R99 None of the above, but in this section

49Sxx Variational principles of physics (should also be assigned at least one other classification number in Section 49)

49S05 Variational principles of physics (should also be assigned at least one other classification number in Section 49)

49S99 None of the above, but in this section

51-XX Geometry {For algebraic geometry, see 14-XX; for differential geometry, see 53-XX}

51-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to geometry

51-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to geometry

51-02 Research exposition (monographs, survey articles) pertaining to geometry

51-03 History of geometry [Consider also classification numbers pertaining to Section 01]

51-04 Software, source code, etc. for problems pertaining to geometry

51-06 Proceedings, conferences, collections, etc. pertaining to geometry

51-08 Computational methods for problems pertaining to geometry

51-11 Research data for problems pertaining to geometry

51Axx Linear incidence geometry

51A05 General theory of linear incidence geometry and projective geometries

51A10 Homomorphism, automorphism and dualities in linear incidence geometry

51A15 Linear incidence geometric structures with parallelism

51A20 Configuration theorems in linear incidence geometry

51A25 Algebraization in linear incidence geometry [See also 12Kxx, 20N05]

51A30 Desarguesian and Pappian geometries

51A35 Non-Desarguesian affine and projective planes

51A40 Translation planes and spreads in linear incidence geometry

51A45 Incidence structures embeddable into projective geometries

51A50 Polar geometry, symplectic spaces, orthogonal spaces

51A99 None of the above, but in this section

51Bxx Nonlinear incidence geometry

51B05 General theory of nonlinear incidence geometry

51B10 Möbius geometries

51B15 Laguerre geometries

51B20 Minkowski geometries in nonlinear incidence geometry

51B25 Lie geometries in nonlinear incidence geometry

51B99 None of the above, but in this section

51Cxx Ring geometry (Hjelmslev, Barbilian, etc.)

51C05 Ring geometry (Hjelmslev, Barbilian, etc.)

51C99 None of the above, but in this section

51Dxx Geometric closure systems

51D05 Abstract (Maeda) geometries

51D10 Abstract geometries with exchange axiom

51D15 Abstract geometries with parallelism

51D20 Combinatorial geometries and geometric closure systems [See also [05B25](#), [05B35](#)]

51D25 Lattices of subspaces and geometric closure systems [See also [05B35](#)]

51D30 Continuous geometries, geometric closure systems and related topics [See also [06Cxx](#)]

51D99 None of the above, but in this section

51Exx Finite geometry and special incidence structures

51E05 General block designs in finite geometry [See also [05B05](#)]

51E10 Steiner systems in finite geometry [See also [05B05](#)]

51E12 Generalized quadrangles and generalized polygons in finite geometry

51E14 Finite partial geometries (general), nets, partial spreads

51E15 Finite affine and projective planes (geometric aspects)

51E20 Combinatorial structures in finite projective spaces [See also [05Bxx](#)]

51E21 Blocking sets, ovals, k -arcs

51E22 Linear codes and caps in Galois spaces [See also [94B05](#)]

51E23 Spreads and packing problems in finite geometry

51E24 Buildings and the geometry of diagrams

51E25 Other finite nonlinear geometries

51E26 Other finite linear geometries

51E30 Other finite incidence structures (geometric aspects) [See also [05B30](#)]

51E99 None of the above, but in this section

51Fxx Metric geometry

51F05 Absolute planes in metric geometry

51F10 Absolute spaces in metric geometry

51F15 Reflection groups, reflection geometries [See also [20H10](#), [20H15](#)] {For Coxeter groups, see [20F55](#)}

51F20 Congruence and orthogonality in metric geometry [See also [20H05](#)]

51F25 Orthogonal and unitary groups in metric geometry [See also [20H05](#)]

51F30 Lipschitz and coarse geometry of metric spaces [See also [53C23](#)]

51F99 None of the above, but in this section

51Gxx Ordered geometries (ordered incidence structures, etc.)

51G05 Ordered geometries (ordered incidence structures, etc.)

51G99 None of the above, but in this section

51Hxx Topological geometry

51H05 General theory of topological geometry

51H10 Topological linear incidence structures

51H15 Topological nonlinear incidence structures

51H20 Topological geometries on manifolds [See also [57-XX](#)]

51H25 Geometries with differentiable structure [See also [53Cxx](#), especially [53C70](#)]

51H30 Geometries with algebraic manifold structure [See also [14-XX](#)]

51H99 None of the above, but in this section

51Jxx Incidence groups

51J05 General theory of incidence groups

51J10 Projective incidence groups

51J15 Kinematic spaces

51J20 Representation by near-fields and near-algebras [See also [12K05](#), [16Y30](#)]

51J99 None of the above, but in this section

51Kxx Distance geometry

51K05 General theory of distance geometry

51K10 Synthetic differential geometry

51K99 None of the above, but in this section

51Lxx Geometric order structures [See also [53C75](#)]

51L05 Geometry of orders of nondifferentiable curves

51L10 Directly differentiable curves in geometric order structures

51L15 n -vertex theorems via direct methods

51L20 Geometry of orders of surfaces

51L99 None of the above, but in this section

51Mxx Real and complex geometry

51M04 Elementary problems in Euclidean geometries

51M05 Euclidean geometries (general) and generalizations

51M09 Elementary problems in hyperbolic and elliptic geometries

51M10 Hyperbolic and elliptic geometries (general) and generalizations

51M15 Geometric constructions in real or complex geometry

51M16 Inequalities and extremum problems in real or complex geometry {For convex problems, see [52A40](#)}

51M20 Polyhedra and polytopes; regular figures, division of spaces [See also [51F15](#)]

51M25 Length, area and volume in real or complex geometry [See also [26B15](#)]

51M30 Line geometries and their generalizations [See also [53A25](#)]

51M35 Synthetic treatment of fundamental manifolds in projective geometries (Grassmannians, Veronesians and their generalizations) [See also [14M15](#)]

51M99 None of the above, but in this section

51Nxx Analytic and descriptive geometry

51N05 Descriptive geometry [See also [65D17](#), [68U07](#)]

51N10 Affine analytic geometry

51N15 Projective analytic geometry

51N20 Euclidean analytic geometry

51N25 Analytic geometry with other transformation groups

51N30 Geometry of classical groups [See also [14L35](#), [20Gxx](#)]

51N35 Questions of classical algebraic geometry [See also [14Nxx](#)]

51N99 None of the above, but in this section

51Pxx Classical or axiomatic geometry and physics (should also be assigned at least one other classification number from Sections [70–86](#))

51P05 Classical or axiomatic geometry and physics (should also be assigned at least one other classification number from Sections [70–86](#))

51P99 None of the above, but in this section

52-XX Convex and discrete geometry

52-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to convex and discrete geometry

52-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to convex and discrete geometry

52-02 Research exposition (monographs, survey articles) pertaining to convex and discrete geometry

52-03 History of convex and discrete geometry [Consider also classification numbers pertaining to Section [01](#)]

52-04 Software, source code, etc. for problems pertaining to convex and discrete geometry

52-06 Proceedings, conferences, collections, etc. pertaining to convex and discrete geometry

52-08 Computational methods for problems pertaining to convex and discrete geometry

52-11 Research data for problems pertaining to convex and discrete geometry

52Axx General convexity

52A01 Axiomatic and generalized convexity

52A05 Convex sets without dimension restrictions (aspects of convex geometry)

52A07 Convex sets in topological vector spaces (aspects of convex geometry) [See also [46A55](#)]

52A10 Convex sets in 2 dimensions (including convex curves) [See also [53A04](#)]

52A15 Convex sets in 3 dimensions (including convex surfaces) [See also [53A05](#), [53C45](#)]

52A20 Convex sets in n dimensions (including convex hypersurfaces) [See also [53A07](#), [53C45](#)]

52A21 Convexity and finite-dimensional Banach spaces (including special norms, zonoids, etc.) (aspects of convex geometry) [See also [46Bxx](#)]

52A22 Random convex sets and integral geometry (aspects of convex geometry) [See also [53C65](#), [60D05](#)]

52A23 Asymptotic theory of convex bodies [See also [46B06](#)]

52A27 Approximation by convex sets

52A30 Variants of convex sets (star-shaped, (m, n) -convex, etc.)

52A35 Helly-type theorems and geometric transversal theory

52A37 Other problems of combinatorial convexity

52A38 Length, area, volume and convex sets (aspects of convex geometry) [See also [26B15](#), [28A75](#), [49Q20](#)]

52A39 Mixed volumes and related topics in convex geometry

52A40 Inequalities and extremum problems involving convexity in convex geometry

52A41 Convex functions and convex programs in convex geometry [See also [26B25](#), [90C25](#)]

52A55 Spherical and hyperbolic convexity

52A99 None of the above, but in this section

52Bxx Polytopes and polyhedra

- 52B05 Combinatorial properties of polytopes and polyhedra (number of faces, shortest paths, etc.) [See also [05Cxx](#)]
- 52B10 Three-dimensional polytopes
- 52B11 n -dimensional polytopes
- 52B12 Special polytopes (linear programming, centrally symmetric, etc.)
- 52B15 Symmetry properties of polytopes
- 52B20 Lattice polytopes in convex geometry (including relations with commutative algebra and algebraic geometry) [See also [06A11](#), [13F20](#), [13F55](#), [13Hxx](#), [52C05](#), [52C07](#)]
- 52B22 Shellability for polytopes and polyhedra
- 52B35 Gale and other diagrams
- 52B40 Matroids in convex geometry (realizations in the context of convex polytopes, convexity in combinatorial structures, etc.) [See also [05B35](#), [52Cxx](#)]
- 52B45 Dissections and valuations (Hilbert's third problem, etc.)
- 52B55 Computational aspects related to convexity {For computational methods, see [52-08](#); for computational geometry and algorithms, see [68Q25](#), [68U05](#); for numerical algorithms, see [65Yxx](#)} [See also [68Uxx](#)]
- 52B60 Isoperimetric problems for polytopes
- 52B70 Polyhedral manifolds
- 52B99 None of the above, but in this section

52Cxx Discrete geometry

- 52C05 Lattices and convex bodies in 2 dimensions (aspects of discrete geometry) [See also [11H06](#), [11H31](#), [11P21](#)]
- 52C07 Lattices and convex bodies in n dimensions (aspects of discrete geometry) [See also [11H06](#), [11H31](#), [11P21](#)]
- 52C10 Erdős problems and related topics of discrete geometry [See also [11Hxx](#)]
- 52C15 Packing and covering in 2 dimensions (aspects of discrete geometry) [See also [05B40](#), [11H31](#)]
- 52C17 Packing and covering in n dimensions (aspects of discrete geometry) [See also [05B40](#), [11H31](#)]
- 52C20 Tilings in 2 dimensions (aspects of discrete geometry) [See also [05B45](#), [51M20](#)]
- 52C22 Tilings in n dimensions (aspects of discrete geometry) [See also [05B45](#), [51M20](#)]
- 52C23 Quasicrystals and aperiodic tilings in discrete geometry
- 52C25 Rigidity and flexibility of structures (aspects of discrete geometry) [See also [70B15](#)]
- 52C26 Circle packings and discrete conformal geometry
- 52C30 Planar arrangements of lines and pseudolines (aspects of discrete geometry)
- 52C35 Arrangements of points, flats, hyperplanes (aspects of discrete geometry) [See also [14N20](#), [32S22](#)]
- 52C40 Oriented matroids in discrete geometry
- 52C45 Combinatorial complexity of geometric structures [See also [68U05](#)]
- 52C99 None of the above, but in this section

53-XX Differential geometry {For differential topology, see [57Rxx](#); for foundational questions of differentiable manifolds, see [58Axx](#)}

53-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to differential geometry

53-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to differential geometry

53-02 Research exposition (monographs, survey articles) pertaining to differential geometry

53-03 History of differential geometry [Consider also classification numbers pertaining to Section [01](#)]

53-04 Software, source code, etc. for problems pertaining to differential geometry

53-06 Proceedings, conferences, collections, etc. pertaining to differential geometry

53-08 Computational methods for problems pertaining to differential geometry

53-11 Research data for problems pertaining to differential geometry

53Axx Classical differential geometry

53A04 Curves in Euclidean and related spaces

53A05 Surfaces in Euclidean and related spaces

53A07 Higher-dimensional and -codimensional surfaces in Euclidean and related n -spaces

53A10 Minimal surfaces in differential geometry, surfaces with prescribed mean curvature [See also [49Q05](#), [49Q10](#), [53C42](#)]

53A15 Affine differential geometry

53A17 Differential geometric aspects in kinematics

53A20 Projective differential geometry

53A25 Differential line geometry

53A30 Differential geometry of submanifolds of Möbius space

53A35 Non-Euclidean differential geometry

53A40 Other special differential geometries

53A45 Differential geometric aspects in vector and tensor analysis

53A55 Differential invariants (local theory), geometric objects

53A60 Differential geometry of webs [See also [14C21](#), [20N05](#)]

53A70 Discrete differential geometry

53A99 None of the above, but in this section

53Bxx Local differential geometry

53B05 Linear and affine connections

53B10 Projective connections

53B12 Differential geometric aspects of statistical manifolds and information geometry

53B15 Other connections

53B20 Local Riemannian geometry

53B21 Methods of local Riemannian geometry

53B25 Local submanifolds [See also [53C40](#)]

53B30 Local differential geometry of Lorentz metrics, indefinite metrics

53B35 Local differential geometry of Hermitian and Kählerian structures [See also [32Qxx](#)]

53B40 Local differential geometry of Finsler spaces and generalizations (areal metrics)

53B50 Applications of local differential geometry to the sciences

53B99 None of the above, but in this section

53Cxx Global differential geometry [See also [51H25](#), [58-XX](#)] {For related bundle theory, see [55Rxx](#), [57Rxx](#)}

53C05 Connections, general theory

53C07 Special connections and metrics on vector bundles (Hermite-Einstein, Yang-Mills) [See also [32Q20](#)]

53C08 Differential geometric aspects of gerbes and differential characters

53C10 G -structures

53C12 Foliations (differential geometric aspects) [See also [57R30](#), [57R32](#)]

53C15 General geometric structures on manifolds (almost complex, almost product structures, etc.)

53C17 Sub-Riemannian geometry

53C18 Conformal structures on manifolds

53C20 Global Riemannian geometry, including pinching [See also [31C12](#), [58B20](#)]

53C21 Methods of global Riemannian geometry, including PDE methods; curvature restrictions [See also [58J60](#)]

53C22 Geodesics in global differential geometry [See also [58E10](#)]

53C23 Global geometric and topological methods (à la Gromov); differential geometric analysis on metric spaces

53C24 Rigidity results

53C25 Special Riemannian manifolds (Einstein, Sasakian, etc.)

53C26 Hyper-Kähler and quaternionic Kähler geometry, “special” geometry

53C27 Spin and Spin^c geometry

53C28 Twistor methods in differential geometry [See also [32L25](#)]

53C29 Issues of holonomy in differential geometry

- 53C30** Differential geometry of homogeneous manifolds [See also [14M15](#), [14M17](#), [32M10](#), [57T15](#)]
- 53C35** Differential geometry of symmetric spaces [See also [32M15](#), [57T15](#)]
- 53C38** Calibrations and calibrated geometries
- 53C40** Global submanifolds [See also [53B25](#)]
- 53C42** Differential geometry of immersions (minimal, prescribed curvature, tight, etc.) [See also [49Q05](#), [49Q10](#), [53A10](#), [57R40](#), [57R42](#)]
- 53C43** Differential geometric aspects of harmonic maps [See also [58E20](#)]
- 53C45** Global surface theory (convex surfaces à la A. D. Aleksandrov)
- 53C50** Global differential geometry of Lorentz manifolds, manifolds with indefinite metrics
- 53C55** Global differential geometry of Hermitian and Kählerian manifolds [See also [32Qxx](#)]
- 53C56** Other complex differential geometry [See also [32Qxx](#)]
- 53C60** Global differential geometry of Finsler spaces and generalizations (areal metrics) [See also [58B20](#)]
- 53C65** Integral geometry [See also [52A22](#), [60D05](#)]; differential forms, currents, etc. [See mainly [58Axx](#)]
- 53C70** Direct methods (G -spaces of Busemann, etc.)
- 53C75** Geometric orders, order geometry [See also [51Lxx](#)]
- 53C80** Applications of global differential geometry to the sciences
- 53C99** None of the above, but in this section

- 53Dxx** **Symplectic geometry, contact geometry** [See also [37Jxx](#), [70Gxx](#), [70Hxx](#)]
- 53D05** Symplectic manifolds, general
- 53D10** Contact manifolds, general
- 53D12** Lagrangian submanifolds; Maslov index
- 53D15** Almost contact and almost symplectic manifolds
- 53D17** Poisson manifolds; Poisson groupoids and algebroids
- 53D18** Generalized geometries (à la Hitchin)
- 53D20** Momentum maps; symplectic reduction
- 53D22** Canonical transformations in symplectic and contact geometry
- 53D25** Geodesic flows in symplectic geometry and contact geometry
- 53D30** Symplectic structures of moduli spaces
- 53D35** Global theory of symplectic and contact manifolds [See also [57Rxx](#)]
- 53D37** Symplectic aspects of mirror symmetry, homological mirror symmetry, and Fukaya category [See also [14J33](#)]
- 53D40** Symplectic aspects of Floer homology and cohomology
- 53D42** Symplectic field theory; contact homology
- 53D45** Gromov-Witten invariants, quantum cohomology, Frobenius manifolds [See also [14N35](#)]
- 53D50** Geometric quantization
- 53D55** Deformation quantization, star products
- 53D99** None of the above, but in this section

53Exx Geometric evolution equations

53E10 Flows related to mean curvature

53E20 Ricci flows

53E30 Flows related to complex manifolds (e.g., Kähler-Ricci flows, Chern-Ricci flows)

53E40 Higher-order geometric flows

53E50 Flows related to symplectic and contact structures

53E99 None of the above, but in this section

53Zxx Applications of differential geometry to sciences and engineering

53Z05 Applications of differential geometry to physics

53Z10 Applications of differential geometry to biology

53Z15 Applications of differential geometry to chemistry

53Z30 Applications of differential geometry to engineering

53Z50 Applications of differential geometry to data and computer science

53Z99 None of the above, but in this section

54-XX General topology {For the topology of manifolds of all dimensions, see [57Nxx](#)}

54-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to general topology

54-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to general topology

54-02 Research exposition (monographs, survey articles) pertaining to general topology

54-03 History of general topology [Consider also classification numbers pertaining to Section [01](#)]

54-04 Software, source code, etc. for problems pertaining to general topology

54-06 Proceedings, conferences, collections, etc. pertaining to general topology

54-08 Computational methods for problems pertaining to general topology

54-11 Research data for problems pertaining to general topology

54Axx Generalities in topology

54A05 Topological spaces and generalizations (closure spaces, etc.)

54A10 Several topologies on one set (change of topology, comparison of topologies, lattices of topologies)

54A15 Syntopogeneous structures

54A20 Convergence in general topology (sequences, filters, limits, convergence spaces, nets, etc.)

54A25 Cardinality properties (cardinal functions and inequalities, discrete subsets) [See also [03Exx](#)] {For ultrafilters, see [54D80](#)}

54A35 Consistency and independence results in general topology [See also [03E35](#)]

54A40 Fuzzy topology [See also [03E72](#)]

54A99 None of the above, but in this section

54Bxx Basic constructions in general topology

- 54B05 Subspaces in general topology
- 54B10 Product spaces in general topology
- 54B15 Quotient spaces, decompositions in general topology
- 54B17 Adjunction spaces and similar constructions in general topology
- 54B20 Hyperspaces in general topology
- 54B30 Categorical methods in general topology [See also [18F60](#)]
- 54B35 Spectra in general topology
- 54B40 Presheaves and sheaves in general topology [See also [18F20](#)]
- 54B99 None of the above, but in this section

54Cxx Maps and general types of topological spaces defined by maps

- 54C05 Continuous maps
- 54C08 Weak and generalized continuity
- 54C10 Special maps on topological spaces (open, closed, perfect, etc.)
- 54C15 Retraction
- 54C20 Extension of maps
- 54C25 Embedding
- 54C30 Real-valued functions in general topology [See also [26-XX](#)]
- 54C35 Function spaces in general topology [See also [46Exx](#), [58D15](#)]
- 54C40 Algebraic properties of function spaces in general topology [See also [46J10](#)]
- 54C45 C - and C^* -embedding
- 54C50 Topology of special sets defined by functions [See also [26A21](#)]
- 54C55 Absolute neighborhood extensor, absolute extensor, absolute neighborhood retract (ANR), absolute retract spaces (general properties) [See also [55M15](#)]
- 54C56 Shape theory in general topology [See also [55P55](#), [57N25](#)]
- 54C60 Set-valued maps in general topology [See also [26E25](#), [28B20](#), [47H04](#), [58C06](#)]
- 54C65 Selections in general topology [See also [28B20](#)]
- 54C70 Entropy in general topology
- 54C99 None of the above, but in this section

54Dxx Fairly general properties of topological spaces

- 54D05 Connected and locally connected spaces (general aspects)
- 54D10 Lower separation axioms (T_0 – T_3 , etc.)
- 54D15 Higher separation axioms (completely regular, normal, perfectly or collectionwise normal, etc.)
- 54D20 Noncompact covering properties (paracompact, Lindelöf, etc.)
- 54D25 “ P -minimal” and “ P -closed” spaces
- 54D30 Compactness
- 54D35 Extensions of spaces (compactifications, supercompactifications, completions, etc.)
- 54D40 Remainders in general topology
- 54D45 Local compactness, σ -compactness
- 54D50 k -spaces
- 54D55 Sequential spaces
- 54D60 Realcompactness and realcompactification
- 54D65 Separability of topological spaces
- 54D70 Base properties of topological spaces
- 54D80 Special constructions of topological spaces (spaces of ultrafilters, etc.)
- 54D99 None of the above, but in this section

54Exx Topological spaces with richer structures

- 54E05 Proximity structures and generalizations
- 54E15 Uniform structures and generalizations
- 54E17 Nearness spaces
- 54E18 p -spaces, M -spaces, σ -spaces, etc.
- 54E20 Stratifiable spaces, cosmic spaces, etc.
- 54E25 Semimetric spaces
- 54E30 Moore spaces
- 54E35 Metric spaces, metrizability
- 54E40 Special maps on metric spaces
- 54E45 Compact (locally compact) metric spaces
- 54E50 Complete metric spaces
- 54E52 Baire category, Baire spaces
- 54E55 Bitopologies
- 54E70 Probabilistic metric spaces
- 54E99 None of the above, but in this section

54Fxx Special properties of topological spaces

54F05 Linearly ordered topological spaces, generalized ordered spaces, and partially ordered spaces [See also [06B30](#), [06F30](#)]

54F15 Continua and generalizations

54F16 Hyperspaces of continua

54F17 Inverse limits of set-valued functions

54F35 Higher-dimensional local connectedness [See also [55Mxx](#), [55Nxx](#)]

54F45 Dimension theory in general topology [See also [55M10](#)]

54F50 Topological spaces of dimension ≤ 1 ; curves, dendrites [See also [26A03](#)]

54F55 Unicoherence, multicoherence

54F65 Topological characterizations of particular spaces

54F99 None of the above, but in this section

54Gxx Peculiar topological spaces

54G05 Extremally disconnected spaces, F -spaces, etc.

54G10 P -spaces

54G12 Scattered spaces

54G15 Pathological topological spaces

54G20 Counterexamples in general topology

54G99 None of the above, but in this section

54Hxx Connections of general topology with other structures, applications

54H05 Descriptive set theory (topological aspects of Borel, analytic, projective, etc. sets) [See also [03E15](#), [26A21](#), [28A05](#)]

54H10 Topological representations of algebraic systems [See also [22-XX](#)]

54H11 Topological groups (topological aspects) [See also [22A05](#)]

54H12 Topological lattices, etc. (topological aspects) [See also [06B30](#), [06F30](#)]

54H13 Topological fields, rings, etc. (topological aspects) [See also [12Jxx](#)] {For algebraic aspects, see [13Jxx](#), [16W80](#)}

54H15 Transformation groups and semigroups (topological aspects) [See also [20M20](#), [22-XX](#), [57Sxx](#)]

54H25 Fixed-point and coincidence theorems (topological aspects) [See also [47H10](#), [55M20](#)]

54H30 Applications of general topology to computer science (e.g., digital topology, image processing) [See also [68U03](#)]

54H99 None of the above, but in this section

54Jxx Nonstandard topology [See also [03H05](#)]

54J05 Nonstandard topology [See also [03H05](#)]

54J99 None of the above, but in this section

55-XX Algebraic topology

55-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to algebraic topology

55-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to algebraic topology

55-02 Research exposition (monographs, survey articles) pertaining to algebraic topology

55-03 History of algebraic topology [Consider also classification numbers pertaining to Section 01]

55-04 Software, source code, etc. for problems pertaining to algebraic topology

55-06 Proceedings, conferences, collections, etc. pertaining to algebraic topology

55-08 Computational methods for problems pertaining to algebraic topology

55-11 Research data for problems pertaining to algebraic topology

55Mxx Classical topics in algebraic topology {For the topology of Euclidean spaces and manifolds, see 57Nxx}

55M05 Duality in algebraic topology

55M10 Dimension theory in algebraic topology [See also 54F45]

55M15 Absolute neighborhood retracts [See also 54C55]

55M20 Fixed points and coincidences in algebraic topology [See also 54H25]

55M25 Degree, winding number

55M30 Lyusternik-Shnirel'man category of a space, topological complexity à la Farber, topological robotics (topological aspects)

55M35 Finite groups of transformations in algebraic topology (including Smith theory) [See also 57S17]

55M99 None of the above, but in this section

55Nxx Homology and cohomology theories in algebraic topology [See also 57Txx]

55N05 Čech types

55N07 Steenrod-Sitnikov homologies

55N10 Singular homology and cohomology theory

55N15 Topological K -theory [See also 19Lxx] {For algebraic K -theory, see 18F25, 19-XX}

55N20 Generalized (extraordinary) homology and cohomology theories in algebraic topology

55N22 Bordism and cobordism theories and formal group laws in algebraic topology [See also 14L05, 19L41, 57R75, 57R77, 57R85, 57R90]

55N25 Homology with local coefficients, equivariant cohomology

55N30 Sheaf cohomology in algebraic topology [See also 18F20, 32C35, 32L10]

55N31 Persistent homology and applications, topological data analysis [See also 62R40, 68T09]

55N32 Orbifold cohomology

55N33 Intersection homology and cohomology in algebraic topology

- 55N34 Elliptic cohomology
- 55N35 Other homology theories in algebraic topology
- 55N40 Axioms for homology theory and uniqueness theorems in algebraic topology
- 55N45 Products and intersections in homology and cohomology
- 55N91 Equivariant homology and cohomology in algebraic topology [See also [19L47](#)]
- 55N99 None of the above, but in this section

- 55Pxx Homotopy theory {For simple homotopy type, see [57Q10](#)}**
- 55P05 Homotopy extension properties, cofibrations in algebraic topology
- 55P10 Homotopy equivalences in algebraic topology
- 55P15 Classification of homotopy type
- 55P20 Eilenberg-Mac Lane spaces
- 55P25 Spanier-Whitehead duality
- 55P30 Eckmann-Hilton duality
- 55P35 Loop spaces
- 55P40 Suspensions
- 55P42 Stable homotopy theory, spectra
- 55P43 Spectra with additional structure (E_∞ , A_∞ , ring spectra, etc.)
- 55P45 H -spaces and duals
- 55P47 Infinite loop spaces
- 55P48 Loop space machines and operads in algebraic topology [See also [18Mxx](#)]
- 55P50 String topology
- 55P55 Shape theory [See also [54C56](#), [55Q07](#)]
- 55P57 Proper homotopy theory
- 55P60 Localization and completion in homotopy theory
- 55P62 Rational homotopy theory
- 55P65 Homotopy functors in algebraic topology
- 55P91 Equivariant homotopy theory in algebraic topology [See also [19L47](#)]
- 55P92 Relations between equivariant and nonequivariant homotopy theory in algebraic topology
- 55P99 None of the above, but in this section

55Qxx Homotopy groups

55Q05 Homotopy groups, general; sets of homotopy classes

55Q07 Shape groups

55Q10 Stable homotopy groups

55Q15 Whitehead products and generalizations

55Q20 Homotopy groups of wedges, joins, and simple spaces

55Q25 Hopf invariants

55Q35 Operations in homotopy groups

55Q40 Homotopy groups of spheres

55Q45 Stable homotopy of spheres

55Q50 J -morphism [See also [19L20](#)]

55Q51 v_n -periodicity

55Q52 Homotopy groups of special spaces

55Q55 Cohomotopy groups

55Q70 Homotopy groups of special types [See also [55N05](#), [55N07](#)]

55Q91 Equivariant homotopy groups [See also [19L47](#)]

55Q99 None of the above, but in this section

55Rxx Fiber spaces and bundles in algebraic topology [See also [18F15](#), [32Lxx](#), [46M20](#), [57R20](#), [57R22](#), [57R25](#)]

55R05 Fiber spaces in algebraic topology

55R10 Fiber bundles in algebraic topology

55R12 Transfer for fiber spaces and bundles in algebraic topology

55R15 Classification of fiber spaces or bundles in algebraic topology

55R20 Spectral sequences and homology of fiber spaces in algebraic topology [See also [55Txx](#)]

55R25 Sphere bundles and vector bundles in algebraic topology

55R35 Classifying spaces of groups and H -spaces in algebraic topology

55R37 Maps between classifying spaces in algebraic topology

55R40 Homology of classifying spaces and characteristic classes in algebraic topology [See also [57Txx](#), [57R20](#)]

55R45 Homology and homotopy of BO and BU ; Bott periodicity

55R50 Stable classes of vector space bundles in algebraic topology and relations to K -theory [See also [19Lxx](#)] {For algebraic K -theory, see [18F25](#), [19-XX](#)}

55R55 Fiberings with singularities in algebraic topology

55R60 Microbundles and block bundles in algebraic topology [See also [57N55](#), [57Q50](#)]

55R65 Generalizations of fiber spaces and bundles in algebraic topology

55R70 Fibrewise topology

55R80 Discriminantal varieties and configuration spaces in algebraic topology

55R91 Equivariant fiber spaces and bundles in algebraic topology [See also [19L47](#)]

55R99 None of the above, but in this section

55Sxx Operations and obstructions in algebraic topology

55S05 Primary cohomology operations in algebraic topology

55S10 Steenrod algebra

55S12 Dyer-Lashof operations

55S15 Symmetric products and cyclic products in algebraic topology

55S20 Secondary and higher cohomology operations in algebraic topology

55S25 K -theory operations and generalized cohomology operations in algebraic topology [See also [19D55](#), [19Lxx](#)]

55S30 Massey products

55S35 Obstruction theory in algebraic topology

55S36 Extension and compression of mappings in algebraic topology

55S37 Classification of mappings in algebraic topology

55S40 Sectioning fiber spaces and bundles in algebraic topology

55S45 Postnikov systems, k -invariants

55S91 Equivariant operations and obstructions in algebraic topology [See also [19L47](#)]

55S99 None of the above, but in this section

55Txx Spectral sequences in algebraic topology [See also [18G40](#), [55R20](#)]

55T05 General theory of spectral sequences in algebraic topology

55T10 Serre spectral sequences

55T15 Adams spectral sequences

55T20 Eilenberg-Moore spectral sequences [See also [57T35](#)]

55T25 Generalized cohomology and spectral sequences in algebraic topology

55T99 None of the above, but in this section

55Uxx Applied homological algebra and category theory in algebraic topology [See also [18Gxx](#)]

55U05 Abstract complexes in algebraic topology

55U10 Simplicial sets and complexes in algebraic topology

55U15 Chain complexes in algebraic topology

55U20 Universal coefficient theorems, Bockstein operator

55U25 Homology of a product, Künneth formula

55U30 Duality in applied homological algebra and category theory (aspects of algebraic topology)

55U35 Abstract and axiomatic homotopy theory in algebraic topology

55U40 Topological categories, foundations of homotopy theory

55U99 None of the above, but in this section

57-XX Manifolds and cell complexes {For complex manifolds, see [32Qxx](#)}

57-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to manifolds and cell complexes

57-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to manifolds and cell complexes

57-02 Research exposition (monographs, survey articles) pertaining to manifolds and cell complexes

57-03 History of manifolds and cell complexes [Consider also classification numbers pertaining to Section [01](#)]

57-04 Software, source code, etc. for problems pertaining to manifolds and cell complexes

57-06 Proceedings, conferences, collections, etc. pertaining to manifolds and cell complexes

57-08 Computational methods for problems pertaining to manifolds and cell complexes

57-11 Research data for problems pertaining to manifolds and cell complexes

57Kxx Low-dimensional topology in specific dimensions

57K10 Knot theory

57K12 Generalized knots (virtual knots, welded knots, quandles, etc.)

57K14 Knot polynomials

57K16 Finite-type and quantum invariants, topological quantum field theories (TQFT)

57K18 Homology theories in knot theory (Khovanov, Heegaard-Floer, etc.)

57K20 2-dimensional topology (including mapping class groups of surfaces, Teichmüller theory, curve complexes, etc.)

57K30 General topology of 3-manifolds

57K31 Invariants of 3-manifolds (also skein modules; character varieties)

57K32 Hyperbolic 3-manifolds

- 57K33** Contact structures in 3 dimensions [See also [57R17](#)]
- 57K35** Other geometric structures on 3-manifolds
- 57K40** General topology of 4-manifolds
- 57K41** Invariants of 4-manifolds (e.g., Donaldson and Seiberg-Witten invariants)
- 57K43** Symplectic structures in 4 dimensions [See also [57R17](#)]
- 57K45** Higher-dimensional knots and links
- 57K50** Low-dimensional manifolds of specific dimension 5 or higher
- 57K99** None of the above, but in this section

57Mxx General low-dimensional topology

- 57M05** Fundamental group, presentations, free differential calculus
- 57M07** Topological methods in group theory
- 57M10** Covering spaces and low-dimensional topology
- 57M12** Low-dimensional topology of special (e.g., branched) coverings
- 57M15** Relations of low-dimensional topology with graph theory [See also [05Cxx](#)]
- 57M30** Wild embeddings
- 57M50** General geometric structures on low-dimensional manifolds
- 57M60** Group actions on manifolds and cell complexes in low dimensions
- 57M99** None of the above, but in this section

57Nxx Topological manifolds

- 57N16** Geometric structures on manifolds of high or arbitrary dimension [See also [57M50](#)]
- 57N17** Topology of topological vector spaces
- 57N20** Topology of infinite-dimensional manifolds [See also [58Bxx](#)]
- 57N25** Shapes (aspects of topological manifolds) [See also [54C56](#), [55P55](#), [55Q07](#)]
- 57N30** Engulfing in topological manifolds
- 57N35** Embeddings and immersions in topological manifolds
- 57N37** Isotopy and pseudo-isotopy
- 57N40** Neighborhoods of submanifolds
- 57N45** Flatness and tameness of topological manifolds
- 57N50** $S^{n-1} \subset E^n$, Schoenflies problem
- 57N55** Microbundles and block bundles [See also [55R60](#), [57Q50](#)]
- 57N60** Cellularity in topological manifolds
- 57N65** Algebraic topology of manifolds

57N70 Cobordism and concordance in topological manifolds

57N75 General position and transversality

57N80 Stratifications in topological manifolds

57N99 None of the above, but in this section

57Pxx **Generalized manifolds** [See also [18F15](#)]

57P05 Local properties of generalized manifolds

57P10 Poincaré duality spaces

57P99 None of the above, but in this section

57Qxx **PL-topology**

57Q05 General topology of complexes

57Q10 Simple homotopy type, Whitehead torsion, Reidemeister-Franz torsion, etc. [See also [19B28](#)]

57Q12 Wall finiteness obstruction for CW-complexes

57Q15 Triangulating manifolds

57Q20 Cobordism in PL-topology

57Q25 Comparison of PL-structures: classification, Hauptvermutung

57Q30 Engulfing

57Q35 Embeddings and immersions in PL-topology

57Q37 Isotopy in PL-topology

57Q40 Regular neighborhoods in PL-topology

57Q50 Microbundles and block bundles [See also [55R60](#), [57N55](#)]

57Q55 Approximations in PL-topology

57Q60 Cobordism and concordance in PL-topology

57Q65 General position and transversality

57Q70 Discrete Morse theory and related ideas in manifold topology

57Q91 Equivariant PL-topology

57Q99 None of the above, but in this section

57Rxx Differential topology {For foundational questions of differentiable manifolds, see [58Axx](#); for infinite-dimensional manifolds, see [58Bxx](#)}

57R05 Triangulating

57R10 Smoothing in differential topology

57R12 Smooth approximations in differential topology

57R15 Specialized structures on manifolds (spin manifolds, framed manifolds, etc.)

57R17 Symplectic and contact topology in high or arbitrary dimension [See also [57K33](#), [57K43](#)]

57R18 Topology and geometry of orbifolds

57R19 Algebraic topology on manifolds and differential topology

57R20 Characteristic classes and numbers in differential topology

57R22 Topology of vector bundles and fiber bundles [See also [55Rxx](#)]

57R25 Vector fields, frame fields in differential topology

57R27 Controllability of vector fields on C^∞ and real-analytic manifolds [See also [49Qxx](#), [37C10](#), [93B05](#)]

57R30 Foliations in differential topology; geometric theory [See also [53C12](#)]

57R32 Classifying spaces for foliations; Gelfand-Fuks cohomology [See also [58H10](#)]

57R35 Differentiable mappings in differential topology

57R40 Embeddings in differential topology

57R42 Immersions in differential topology

57R45 Singularities of differentiable mappings in differential topology

57R50 Differential topological aspects of diffeomorphisms

57R52 Isotopy in differential topology

57R55 Differentiable structures in differential topology

57R56 Topological quantum field theories (aspects of differential topology)

57R57 Applications of global analysis to structures on manifolds [See also [57K41](#), [58-XX](#)]

57R58 Floer homology

57R60 Homotopy spheres, Poincaré conjecture

57R65 Surgery and handlebodies

57R67 Surgery obstructions, Wall groups [See also [19J25](#)]

57R70 Critical points and critical submanifolds in differential topology

57R75 O- and SO-cobordism

57R77 Complex cobordism (U- and SU-cobordism) [See also [55N22](#)]

57R80 h - and s -cobordism

57R85 Equivariant cobordism

57R90 Other types of cobordism [See also [55N22](#)]

57R91 Equivariant algebraic topology of manifolds

57R95 Realizing cycles by submanifolds

57R99 None of the above, but in this section

57Sxx Topological transformation groups [See also [20F34](#), [22-XX](#), [37-XX](#), [54H15](#), [58D05](#)]

57S05 Topological properties of groups of homeomorphisms or diffeomorphisms

57S10 Compact groups of homeomorphisms

57S12 Toric topology

57S15 Compact Lie groups of differentiable transformations

57S17 Finite transformation groups

57S20 Noncompact Lie groups of transformations

57S25 Groups acting on specific manifolds

57S30 Discontinuous groups of transformations

57S99 None of the above, but in this section

57Txx Homology and homotopy of topological groups and related structures

57T05 Hopf algebras (aspects of homology and homotopy of topological groups) [See also [16T05](#)]

57T10 Homology and cohomology of Lie groups

57T15 Homology and cohomology of homogeneous spaces of Lie groups

57T20 Homotopy groups of topological groups and homogeneous spaces

57T25 Homology and cohomology of H -spaces

57T30 Bar and cobar constructions [See also [18N40](#), [55Uxx](#)]

57T35 Applications of Eilenberg-Moore spectral sequences [See also [55R20](#), [55T20](#)]

57T99 None of the above, but in this section

57Zxx Relations of manifolds and cell complexes with science and engineering

57Z05 Relations of manifolds and cell complexes with physics

57Z10 Relations of manifolds and cell complexes with biology

57Z15 Relations of manifolds and cell complexes with chemistry

57Z20 Relations of manifolds and cell complexes with engineering

57Z25 Relations of manifolds and cell complexes with computer and data science

57Z99 None of the above, but in this section

58-XX Global analysis, analysis on manifolds [See also [32Cxx](#), [32Fxx](#), [32Wxx](#), [46-XX](#), [47Hxx](#), [53Cxx](#)] {For geometric integration theory, see [49Q15](#)}

58-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to global analysis

58-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to global analysis

58-02 Research exposition (monographs, survey articles) pertaining to global analysis

58-03 History of global analysis [Consider also classification numbers pertaining to Section [01](#)]

58-04 Software, source code, etc. for problems pertaining to global analysis

58-06 Proceedings, conferences, collections, etc. pertaining to global analysis

58-08 Computational methods for problems pertaining to global analysis

58-11 Research data for problems pertaining to global analysis

58Axx General theory of differentiable manifolds [See also [32Cxx](#)]

58A03 Topos-theoretic approach to differentiable manifolds

58A05 Differentiable manifolds, foundations

58A07 Real-analytic and Nash manifolds [See also [14P20](#), [32C07](#)]

58A10 Differential forms in global analysis

58A12 de Rham theory in global analysis [See also [14Fxx](#)]

58A14 Hodge theory in global analysis [See also [14C30](#), [14Fxx](#), [32J25](#), [32S35](#)]

58A15 Exterior differential systems (Cartan theory)

58A17 Pfaffian systems

58A20 Jets in global analysis

58A25 Currents in global analysis [See also [32C30](#), [53C65](#)]

58A30 Vector distributions (subbundles of the tangent bundles)

58A32 Natural bundles

58A35 Stratified sets [See also [32S60](#)]

58A40 Differential spaces

58A50 Supermanifolds and graded manifolds [See also [14A22](#), [32C11](#)]

58A99 None of the above, but in this section

58Bxx Infinite-dimensional manifolds

58B05 Homotopy and topological questions for infinite-dimensional manifolds

58B10 Differentiability questions for infinite-dimensional manifolds

58B12 Questions of holomorphy and infinite-dimensional manifolds [See also [32-XX](#), [46G20](#)]

58B15 Fredholm structures on infinite-dimensional manifolds [See also [47A53](#)]

58B20 Riemannian, Finsler and other geometric structures on infinite-dimensional manifolds [See also [53C20](#), [53C60](#)]

58B25 Group structures and generalizations on infinite-dimensional manifolds [See also [22E65](#), [58D05](#)]

58B32 Geometry of quantum groups

58B34 Noncommutative geometry (à la Connes)

58B99 None of the above, but in this section

58Cxx Calculus on manifolds; nonlinear operators [See also [46Txx](#), [47Hxx](#), [47Jxx](#)]

58C05 Real-valued functions on manifolds

58C06 Set-valued and function-space-valued mappings on manifolds [See also [47H04](#), [54C60](#)]

58C07 Continuity properties of mappings on manifolds

58C10 Holomorphic maps on manifolds [See also [32-XX](#)]

58C15 Implicit function theorems; global Newton methods on manifolds

58C20 Differentiation theory (Gateaux, Fréchet, etc.) on manifolds [See also [26Exx](#), [46G05](#)]

58C25 Differentiable maps on manifolds

58C30 Fixed-point theorems on manifolds [See also [47H10](#)]

58C35 Integration on manifolds; measures on manifolds [See also [28Cxx](#)]

58C40 Spectral theory; eigenvalue problems on manifolds [See also [47J10](#), [58E07](#)]

58C50 Analysis on supermanifolds or graded manifolds

58C99 None of the above, but in this section

58Dxx Spaces and manifolds of mappings (including nonlinear versions of [46Exx](#)) [See also [46Txx](#), [53Cxx](#)]

58D05 Groups of diffeomorphisms and homeomorphisms as manifolds [See also [22E65](#), [57S05](#)]

58D07 Groups and semigroups of nonlinear operators [See also [17B65](#), [47H20](#)]

58D10 Spaces of embeddings and immersions

58D15 Manifolds of mappings [See also [46T10](#), [54C35](#)]

58D17 Manifolds of metrics (especially Riemannian)

58D19 Group actions and symmetry properties

58D20 Measures (Gaussian, cylindrical, etc.) on manifolds of maps [See also [28Cxx](#), [46T12](#)]

58D25 Equations in function spaces; evolution equations [See also [34Gxx](#), [35K90](#), [35L90](#), [35R15](#), [37Lxx](#), [47Jxx](#)]

58D27 Moduli problems for differential geometric structures

58D29 Moduli problems for topological structures

58D30 Applications of manifolds of mappings to the sciences

58D99 None of the above, but in this section

58Exx Variational problems in infinite-dimensional spaces

58E05 Abstract critical point theory (Morse theory, Lyusternik-Shnirel'man theory, etc.) in infinite-dimensional spaces

58E07 Variational problems in abstract bifurcation theory in infinite-dimensional spaces

58E09 Group-invariant bifurcation theory in infinite-dimensional spaces

58E10 Variational problems in applications to the theory of geodesics (problems in one independent variable)

58E11 Critical metrics

58E12 Variational problems concerning minimal surfaces (problems in two independent variables) [See also [49Q05](#)]

58E15 Variational problems concerning extremal problems in several variables; Yang-Mills functionals [See also [81T13](#)], etc.

58E17 Multiobjective variational problems, Pareto optimality, applications to economics, etc. [See also [90C29](#), [91Bxx](#)]

58E20 Harmonic maps, etc. [See also [53C43](#)]

58E25 Applications of variational problems to control theory [See also [49-XX](#), [93-XX](#)]

58E30 Variational principles in infinite-dimensional spaces

58E35 Variational inequalities (global problems) in infinite-dimensional spaces

58E40 Variational aspects of group actions in infinite-dimensional spaces

58E50 Applications of variational problems in infinite-dimensional spaces to the sciences

58E99 None of the above, but in this section

58Hxx Pseudogroups, differentiable groupoids and general structures on manifolds

58H05 Pseudogroups and differentiable groupoids [See also [22A22](#), [22E65](#)]

58H10 Cohomology of classifying spaces for pseudogroup structures (Spencer, Gelfand-Fuks, etc.) [See also [57R32](#)]

58H15 Deformations of general structures on manifolds [See also [32Gxx](#), [58J10](#)]

58H99 None of the above, but in this section

- 58Jxx Partial differential equations on manifolds; differential operators** [See also [32Wxx](#), [35-XX](#), [53Cxx](#)]
- 58J05** Elliptic equations on manifolds, general theory [See also [35-XX](#)]
- 58J10** Differential complexes [See also [35Nxx](#)]; elliptic complexes
- 58J15** Relations of PDEs on manifolds with hyperfunctions
- 58J20** Index theory and related fixed-point theorems on manifolds [See also [19K56](#), [46L80](#)]
- 58J22** Exotic index theories on manifolds [See also [19K56](#), [46L05](#), [46L10](#), [46L80](#), [46M20](#)]
- 58J26** Elliptic genera
- 58J28** Eta-invariants, Chern-Simons invariants
- 58J30** Spectral flows
- 58J32** Boundary value problems on manifolds
- 58J35** Heat and other parabolic equation methods for PDEs on manifolds
- 58J37** Perturbations of PDEs on manifolds; asymptotics
- 58J40** Pseudodifferential and Fourier integral operators on manifolds [See also [35Sxx](#)]
- 58J42** Noncommutative global analysis, noncommutative residues
- 58J45** Hyperbolic equations on manifolds [See also [35Lxx](#)]
- 58J47** Propagation of singularities; initial value problems on manifolds
- 58J50** Spectral problems; spectral geometry; scattering theory on manifolds [See also [35Pxx](#)]
- 58J51** Relations between spectral theory and ergodic theory, e.g., quantum unique ergodicity
- 58J52** Determinants and determinant bundles, analytic torsion
- 58J53** Isospectrality
- 58J55** Bifurcation theory for PDEs on manifolds [See also [35B32](#)]
- 58J60** Relations of PDEs with special manifold structures (Riemannian, Finsler, etc.)
- 58J65** Diffusion processes and stochastic analysis on manifolds [See also [35R60](#), [60H10](#), [60J60](#)]
- 58J70** Invariance and symmetry properties for PDEs on manifolds [See also [35A30](#)]
- 58J72** Correspondences and other transformation methods (e.g., Lie-Bäcklund) for PDEs on manifolds [See also [35A22](#)]
- 58J90** Applications of PDEs on manifolds
- 58J99** None of the above, but in this section

58Kxx Theory of singularities and catastrophe theory [See also [32Sxx](#), [37-XX](#)]

58K05 Critical points of functions and mappings on manifolds

58K10 Monodromy on manifolds

58K15 Topological properties of mappings on manifolds

58K20 Algebraic and analytic properties of mappings on manifolds

58K25 Stability theory for manifolds

58K30 Global theory of singularities

58K35 Catastrophe theory

58K40 Classification; finite determinacy of map germs

58K45 Singularities of vector fields, topological aspects

58K50 Normal forms on manifolds

58K55 Asymptotic behavior of solutions to equations on manifolds

58K60 Deformation of singularities

58K65 Topological invariants on manifolds

58K70 Symmetries, equivariance on manifolds

58K99 None of the above, but in this section

58Zxx Applications of global analysis to the sciences

58Z05 Applications of global analysis to the sciences

58Z99 None of the above, but in this section

60-XX Probability theory and stochastic processes {For additional applications, see [05Cxx](#), [11Kxx](#), [34-XX](#), [35-XX](#), [62-XX](#), [90-XX](#), [76-XX](#), [81-XX](#), [82-XX](#), [91-XX](#), [92-XX](#), [93-XX](#), [94-XX](#)}

60-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to probability theory

60-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to probability theory

60-02 Research exposition (monographs, survey articles) pertaining to probability theory

60-03 History of probability theory [Consider also classification numbers pertaining to Section [01](#)]

60-04 Software, source code, etc. for problems pertaining to probability theory

60-06 Proceedings, conferences, collections, etc. pertaining to probability theory

60-08 Computational methods for problems pertaining to probability theory

60-11 Research data for problems pertaining to probability theory

60Axx Foundations of probability theory

60A05 Axioms; other general questions in probability

60A10 Probabilistic measure theory {For ergodic theory, see [28Dxx](#), [60Fxx](#)}

60A86 Fuzzy probability

60A99 None of the above, but in this section

60Bxx Probability theory on algebraic and topological structures

60B05 Probability measures on topological spaces

60B10 Convergence of probability measures

60B11 Probability theory on linear topological spaces [See also [28C20](#)]

60B12 Limit theorems for vector-valued random variables (infinite-dimensional case)

60B15 Probability measures on groups or semigroups, Fourier transforms, factorization

60B20 Random matrices (probabilistic aspects) {For algebraic aspects, see [15B52](#)}

60B99 None of the above, but in this section

60Cxx Combinatorial probability

60C05 Combinatorial probability

60C99 None of the above, but in this section

60Dxx Geometric probability and stochastic geometry [See also [52A22](#), [53C65](#)]

60D05 Geometric probability and stochastic geometry [See also [52A22](#), [53C65](#)]

60D99 None of the above, but in this section

60Exx Distribution theory [See also [62Exx](#), [62Hxx](#)]

60E05 Probability distributions: general theory

60E07 Infinitely divisible distributions; stable distributions

60E10 Characteristic functions; other transforms

60E15 Inequalities; stochastic orderings

60E99 None of the above, but in this section

60Fxx Limit theorems in probability theory [See also [28Dxx](#), [60B12](#)]

60F05 Central limit and other weak theorems

60F10 Large deviations

60F15 Strong limit theorems

60F17 Functional limit theorems; invariance principles

60F20 Zero-one laws

60F25 L^p -limit theorems

60F99 None of the above, but in this section

60Gxx Stochastic processes

60G05 Foundations of stochastic processes

60G07 General theory of stochastic processes

60G09 Exchangeability for stochastic processes

60G10 Stationary stochastic processes

60G12 General second-order stochastic processes

60G15 Gaussian processes

60G17 Sample path properties

60G18 Self-similar stochastic processes

60G20 Generalized stochastic processes

60G22 Fractional processes, including fractional Brownian motion

60G25 Prediction theory (aspects of stochastic processes) [See also [62M20](#)]

60G30 Continuity and singularity of induced measures

60G35 Signal detection and filtering (aspects of stochastic processes) [See also [62M20](#), [93E10](#), [93E11](#), [94Axx](#)]

60G40 Stopping times; optimal stopping problems; gambling theory [See also [62L15](#), [91A60](#)]

60G42 Martingales with discrete parameter

60G44 Martingales with continuous parameter

60G46 Martingales and classical analysis

60G48 Generalizations of martingales

60G50 Sums of independent random variables; random walks

60G51 Processes with independent increments; Lévy processes

60G52 Stable stochastic processes

60G53 Feller processes

60G55 Point processes (e.g., Poisson, Cox, Hawkes processes)

60G57 Random measures

60G60 Random fields

60G65 Nonlinear processes (e.g., G -Brownian motion, G -Lévy processes)

60G70 Extreme value theory; extremal stochastic processes

60G99 None of the above, but in this section

60Hxx Stochastic analysis [See also [58J65](#)]

60H05 Stochastic integrals

60H07 Stochastic calculus of variations and the Malliavin calculus

60H10 Stochastic ordinary differential equations (aspects of stochastic analysis) [See also [34F05](#)]

60H15 Stochastic partial differential equations (aspects of stochastic analysis) [See also [35R60](#)]

60H17 Singular stochastic partial differential equations

60H20 Stochastic integral equations

60H25 Random operators and equations (aspects of stochastic analysis) [See also [47B80](#)]

60H30 Applications of stochastic analysis (to PDEs, etc.)

60H35 Computational methods for stochastic equations (aspects of stochastic analysis) [See also [65C30](#)]

60H40 White noise theory

60H50 Regularization by noise

60H99 None of the above, but in this section

60Jxx Markov processes

60J05 Discrete-time Markov processes on general state spaces

60J10 Markov chains (discrete-time Markov processes on discrete state spaces)

60J20 Applications of Markov chains and discrete-time Markov processes on general state spaces (social mobility, learning theory, industrial processes, etc.) [See also [90B30](#), [91D10](#), [91E40](#)]

60J22 Computational methods in Markov chains [See also [65C40](#)]

60J25 Continuous-time Markov processes on general state spaces

60J27 Continuous-time Markov processes on discrete state spaces

60J28 Applications of continuous-time Markov processes on discrete state spaces

60J35 Transition functions, generators and resolvents [See also [47D03](#), [47D07](#)]

60J40 Right processes

60J45 Probabilistic potential theory [See also [31Cxx](#), [31D05](#)]

60J46 Dirichlet form methods in Markov processes

60J50 Boundary theory for Markov processes

60J55 Local time and additive functionals

60J57 Multiplicative functionals and Markov processes

60J60 Diffusion processes [See also [58J65](#)]

60J65 Brownian motion [See also [58J65](#)]

60J67 Stochastic (Schramm-)Loewner evolution (SLE)

60J68 Superprocesses

- 60J70** Applications of Brownian motions and diffusion theory (population genetics, absorption problems, etc.) [See also [92Dxx](#)]
- 60J75** Jump processes on discrete state spaces
- 60J76** Jump processes on general state spaces
- 60J80** Branching processes (Galton-Watson, birth-and-death, etc.)
- 60J85** Applications of branching processes [See also [92Dxx](#)]
- 60J90** Coalescent processes
- 60J95** Applications of coalescent processes [See also [92Dxx](#)]
- 60J99** None of the above, but in this section

60Kxx Special processes

- 60K05** Renewal theory
- 60K10** Applications of renewal theory (reliability, demand theory, etc.)
- 60K15** Markov renewal processes, semi-Markov processes
- 60K20** Applications of Markov renewal processes (reliability, queueing networks, etc.) [See also [90Bxx](#)]
- 60K25** Queueing theory (aspects of probability theory) [See also [68M20](#), [90B22](#)]
- 60K30** Applications of queueing theory (congestion, allocation, storage, traffic, etc.) [See also [90Bxx](#)]
- 60K35** Interacting random processes; statistical mechanics type models; percolation theory [See also [82B43](#), [82C43](#)]
- 60K37** Processes in random environments
- 60K40** Other physical applications of random processes
- 60K50** Anomalous diffusion models (subdiffusion, superdiffusion, continuous-time random walks, etc.) [See also [60G22](#), [60G55](#), [60J75](#)] {For applications to physics and the sciences, see [76-XX](#), [82Cxx](#), [92-XX](#)}
- 60K99** None of the above, but in this section

60Lxx Rough analysis

- 60L10** Signatures and data streams
- 60L20** Rough paths
- 60L30** Regularity structures
- 60L40** Paracontrolled distributions and alternative approaches
- 60L50** Rough partial differential equations
- 60L70** Algebraic structures and computation
- 60L90** Applications of rough analysis
- 60L99** None of the above, but in this section

62-XX Statistics

62-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to statistics

62-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to statistics

62-02 Research exposition (monographs, survey articles) pertaining to statistics

62-03 History of statistics [Consider also classification numbers pertaining to Section [01](#)]

62-04 Software, source code, etc. for problems pertaining to statistics

62-06 Proceedings, conferences, collections, etc. pertaining to statistics

62-08 Computational methods for problems pertaining to statistics

62-11 Research data for problems pertaining to statistics

62Axx Foundational and philosophical topics in statistics

62A01 Foundations and philosophical topics in statistics

62A09 Graphical methods

62A86 Fuzzy analysis in statistics

62A99 None of the above, but in this section

62Bxx Sufficiency and information

62B05 Sufficient statistics and fields

62B10 Statistical aspects of information-theoretic topics [See also [94A17](#)]

62B11 Information geometry (statistical aspects) {For differential geometric aspects, see [53B12](#)}

62B15 Theory of statistical experiments

62B86 Statistical aspects of fuzziness, sufficiency, and information

62B99 None of the above, but in this section

62Cxx Statistical decision theory [See also [90B50](#), [91B06](#)] {For game theory, see [91A35](#)}

62C05 General considerations in statistical decision theory

62C07 Complete class results in statistical decision theory

62C10 Bayesian problems; characterization of Bayes procedures

62C12 Empirical decision procedures; empirical Bayes procedures

62C15 Admissibility in statistical decision theory

62C20 Minimax procedures in statistical decision theory

62C25 Compound decision problems in statistical decision theory

62C86 Statistical decision theory and fuzziness

62C99 None of the above, but in this section

62Dxx Statistical sampling theory, sample surveys

62D05 Sampling theory, sample surveys

62D10 Missing data

62D20 Causal inference from observational studies

62D99 None of the above, but in this section

62Exx Statistical distribution theory [See also [60Exx](#)]

62E10 Characterization and structure theory of statistical distributions

62E15 Exact distribution theory in statistics

62E17 Approximations to statistical distributions (nonasymptotic)

62E20 Asymptotic distribution theory in statistics

62E86 Fuzziness in connection with statistical distributions

62E99 None of the above, but in this section

62Fxx Parametric inference

62F03 Parametric hypothesis testing

62F05 Asymptotic properties of parametric tests

62F07 Statistical ranking and selection procedures

62F10 Point estimation

62F12 Asymptotic properties of parametric estimators

62F15 Bayesian inference

62F25 Parametric tolerance and confidence regions

62F30 Parametric inference under constraints

62F35 Robustness and adaptive procedures (parametric inference)

62F40 Bootstrap, jackknife and other resampling methods

62F86 Parametric inference and fuzziness

62F99 None of the above, but in this section

62Gxx Nonparametric inference

62G05 Nonparametric estimation

62G07 Density estimation

62G08 Nonparametric regression and quantile regression

62G09 Nonparametric statistical resampling methods

62G10 Nonparametric hypothesis testing

62G15 Nonparametric tolerance and confidence regions

62G20 Asymptotic properties of nonparametric inference

62G30 Order statistics; empirical distribution functions

62G32 Statistics of extreme values; tail inference

62G35 Nonparametric robustness

62G86 Nonparametric inference and fuzziness

62G99 None of the above, but in this section

62Hxx Multivariate analysis [See also [60Exx](#)]

62H05 Characterization and structure theory for multivariate probability distributions; copulas

62H10 Multivariate distribution of statistics

62H11 Directional data; spatial statistics

62H12 Estimation in multivariate analysis

62H15 Hypothesis testing in multivariate analysis

62H17 Contingency tables

62H20 Measures of association (correlation, canonical correlation, etc.)

62H22 Probabilistic graphical models

62H25 Factor analysis and principal components; correspondence analysis

62H30 Classification and discrimination; cluster analysis (statistical aspects) [See also [68T10](#), [91C20](#)]; mixture models

62H35 Image analysis in multivariate analysis

62H86 Multivariate analysis and fuzziness

62H99 None of the above, but in this section

62Jxx Linear inference, regression

62J02 General nonlinear regression

62J05 Linear regression; mixed models

62J07 Ridge regression; shrinkage estimators (Lasso)

62J10 Analysis of variance and covariance (ANOVA)

62J12 Generalized linear models (logistic models)

62J15 Paired and multiple comparisons; multiple testing

62J20 Diagnostics, and linear inference and regression

62J86 Fuzziness, and linear inference and regression

62J99 None of the above, but in this section

62Kxx Design of statistical experiments [See also [05Bxx](#)]

62K05 Optimal statistical designs

62K10 Statistical block designs

62K15 Factorial statistical designs

62K20 Response surface designs

62K25 Robust parameter designs

62K86 Fuzziness and design of statistical experiments

62K99 None of the above, but in this section

62Lxx Sequential statistical methods

62L05 Sequential statistical design

62L10 Sequential statistical analysis

62L12 Sequential estimation

62L15 Optimal stopping in statistics [See also [60G40](#), [91A60](#)]

62L20 Stochastic approximation

62L86 Fuzziness and sequential statistical methods

62L99 None of the above, but in this section

62Mxx Inference from stochastic processes

62M02 Markov processes: hypothesis testing

62M05 Markov processes: estimation; hidden Markov models

62M07 Non-Markovian processes: hypothesis testing

62M09 Non-Markovian processes: estimation

62M10 Time series, auto-correlation, regression, etc. in statistics (GARCH) [See also [91B84](#)]

62M15 Inference from stochastic processes and spectral analysis

62M20 Inference from stochastic processes and prediction [See also [60G25](#)]; filtering [See also [60G35](#), [93E10](#), [93E11](#)]

62M30 Inference from spatial processes

62M40 Random fields; image analysis

62M45 Neural nets and related approaches to inference from stochastic processes

62M86 Inference from stochastic processes and fuzziness

62M99 None of the above, but in this section

62Nxx Survival analysis and censored data

- 62N01** Censored data models
- 62N02** Estimation in survival analysis and censored data
- 62N03** Testing in survival analysis and censored data
- 62N05** Reliability and life testing [See also [90B25](#)]
- 62N86** Fuzziness, and survival analysis and censored data
- 62N99** None of the above, but in this section

62Pxx Applications of statistics [See also [90-XX](#), [91-XX](#), [92-XX](#)]

- 62P05** Applications of statistics to actuarial sciences and financial mathematics
- 62P10** Applications of statistics to biology and medical sciences; meta analysis
- 62P12** Applications of statistics to environmental and related topics
- 62P15** Applications of statistics to psychology
- 62P20** Applications of statistics to economics [See also [91Bxx](#)]
- 62P25** Applications of statistics to social sciences
- 62P30** Applications of statistics in engineering and industry; control charts
- 62P35** Applications of statistics to physics
- 62P99** None of the above, but in this section

62Qxx Statistical tables

- 62Q05** Statistical tables
- 62Q99** None of the above, but in this section

62Rxx Statistics on algebraic and topological structures

- 62R01** Algebraic statistics
- 62R07** Statistical aspects of big data and data science {For computer science aspects, see [68T09](#); for information-theoretic aspects, see [94A16](#)}
- 62R10** Functional data analysis
- 62R20** Statistics on metric spaces
- 62R30** Statistics on manifolds
- 62R40** Topological data analysis [See also [55N31](#)]
- 62R99** None of the above, but in this section

65-XX Numerical analysis

65-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to numerical analysis

65-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to numerical analysis

65-02 Research exposition (monographs, survey articles) pertaining to numerical analysis

65-03 History of numerical analysis [Consider also classification numbers pertaining to Section [01](#)]

65-04 Software, source code, etc. for problems pertaining to numerical analysis

65-06 Proceedings, conferences, collections, etc. pertaining to numerical analysis

65-11 Research data for problems pertaining to numerical analysis

65Axx Tables in numerical analysis

65A05 Tables in numerical analysis

65A99 None of the above, but in this section

65Bxx Acceleration of convergence in numerical analysis

65B05 Extrapolation to the limit, deferred corrections

65B10 Numerical summation of series

65B15 Euler-Maclaurin formula in numerical analysis

65B99 None of the above, but in this section

65Cxx Probabilistic methods, stochastic differential equations

65C05 Monte Carlo methods [See also [82M31](#)]

65C10 Random number generation in numerical analysis [See also [11K45](#)]

65C20 Probabilistic models, generic numerical methods in probability and statistics [See also [60-08](#), [62-08](#)]

65C30 Numerical solutions to stochastic differential and integral equations {For theoretical aspects, see [60H35](#)}
[See also [65M75](#), [65N75](#)]

65C35 Stochastic particle methods [See also [82M60](#)]

65C40 Numerical analysis or methods applied to Markov chains [See also [60J22](#)]

65C99 None of the above, but in this section

65Dxx Numerical approximation and computational geometry (primarily algorithms) {For theoretical aspects, see [41-XX](#), [68Uxx](#)}

65D05 Numerical interpolation

65D07 Numerical computation using splines

65D10 Numerical smoothing, curve fitting

65D12 Numerical radial basis function approximation

65D15 Algorithms for approximation of functions

- 65D17** Computer-aided design (modeling of curves and surfaces) [See also [68U07](#)]
- 65D18** Numerical aspects of computer graphics, image analysis, and computational geometry [See also [51N05](#), [68U05](#)]
- 65D19** Computational issues in computer and robotic vision
- 65D20** Computation of special functions and constants, construction of tables [See also [33F05](#)]
- 65D25** Numerical differentiation
- 65D30** Numerical integration
- 65D32** Numerical quadrature and cubature formulas
- 65D40** High-dimensional functions; sparse grids
- 65D99** None of the above, but in this section
- 65Exx Numerical methods in complex analysis (potential theory, etc.)**
- 65E05** Numerical methods in complex analysis (potential theory, etc.) [See also [30-08](#), [31-08](#), [32-08](#)]
- 65E10** Numerical methods in conformal mappings [See also [30C30](#)]
- 65E99** None of the above, but in this section
- 65Fxx Numerical linear algebra**
- 65F05** Direct numerical methods for linear systems and matrix inversion
- 65F08** Preconditioners for iterative methods
- 65F10** Iterative numerical methods for linear systems [See also [65N22](#)]
- 65F15** Numerical computation of eigenvalues and eigenvectors of matrices
- 65F18** Numerical solutions to inverse eigenvalue problems
- 65F20** Numerical solutions to overdetermined systems, pseudoinverses
- 65F22** Ill-posedness and regularization problems in numerical linear algebra
- 65F25** Orthogonalization in numerical linear algebra
- 65F30** Other numerical matrix algorithms
- 65F35** Numerical computation of matrix norms, conditioning, scaling [See also [15A12](#), [15A60](#)]
- 65F40** Numerical computation of determinants
- 65F45** Numerical methods for matrix equations
- 65F50** Computational methods for sparse matrices
- 65F55** Numerical methods for low-rank matrix approximation; matrix compression
- 65F60** Numerical computation of matrix exponential and similar matrix functions
- 65F99** None of the above, but in this section

65Gxx Error analysis and interval analysis

65G20 Algorithms with automatic result verification

65G30 Interval and finite arithmetic

65G40 General methods in interval analysis

65G50 Roundoff error

65G99 None of the above, but in this section

65Hxx Nonlinear algebraic or transcendental equations

65H04 Numerical computation of roots of polynomial equations

65H05 Numerical computation of solutions to single equations

65H10 Numerical computation of solutions to systems of equations

65H14 Numerical algebraic geometry

65H17 Numerical solution of nonlinear eigenvalue and eigenvector problems [See also [47Hxx](#), [47Jxx](#), [58C40](#), [58E07](#), [90C30](#)]

65H20 Global methods, including homotopy approaches to the numerical solution of nonlinear equations [See also [58C30](#), [90C30](#)]

65H99 None of the above, but in this section

65Jxx Numerical analysis in abstract spaces

65J05 General theory of numerical analysis in abstract spaces

65J08 Numerical solutions to abstract evolution equations

65J10 Numerical solutions to equations with linear operators (do not use [65Fxx](#))

65J15 Numerical solutions to equations with nonlinear operators (do not use [65Hxx](#))

65J20 Numerical solutions of ill-posed problems in abstract spaces; regularization

65J22 Numerical solution to inverse problems in abstract spaces

65J99 None of the above, but in this section

65Kxx Numerical methods for mathematical programming, optimization and variational techniques

65K05 Numerical mathematical programming methods [See also [90Cxx](#)]

65K10 Numerical optimization and variational techniques [See also [49Mxx](#), [93-08](#)]

65K15 Numerical methods for variational inequalities and related problems

65K99 None of the above, but in this section

65Lxx Numerical methods for ordinary differential equations

- 65L03** Numerical methods for functional-differential equations
- 65L04** Numerical methods for stiff equations
- 65L05** Numerical methods for initial value problems
- 65L06** Multistep, Runge-Kutta and extrapolation methods for ordinary differential equations
- 65L07** Numerical investigation of stability of solutions
- 65L08** Numerical solution of ill-posed problems involving ordinary differential equations
- 65L09** Numerical solution of inverse problems involving ordinary differential equations
- 65L10** Numerical solution of boundary value problems involving ordinary differential equations
- 65L11** Numerical solution of singularly perturbed problems involving ordinary differential equations
- 65L12** Finite difference and finite volume methods for ordinary differential equations
- 65L15** Numerical solution of eigenvalue problems involving ordinary differential equations
- 65L20** Stability and convergence of numerical methods for ordinary differential equations
- 65L50** Mesh generation, refinement, and adaptive methods for ordinary differential equations
- 65L60** Finite element, Rayleigh-Ritz, Galerkin and collocation methods for ordinary differential equations
- 65L70** Error bounds for numerical methods for ordinary differential equations
- 65L80** Numerical methods for differential-algebraic equations
- 65L99** None of the above, but in this section

65Mxx Numerical methods for partial differential equations, initial value and time-dependent initial-boundary value problems

- 65M06** Finite difference methods for initial value and initial-boundary value problems involving PDEs
- 65M08** Finite volume methods for initial value and initial-boundary value problems involving PDEs
- 65M12** Stability and convergence of numerical methods for initial value and initial-boundary value problems involving PDEs
- 65M15** Error bounds for initial value and initial-boundary value problems involving PDEs
- 65M20** Method of lines for initial value and initial-boundary value problems involving PDEs
- 65M22** Numerical solution of discretized equations for initial value and initial-boundary value problems involving PDEs [See also [65Fxx](#), [65Hxx](#)]
- 65M25** Numerical aspects of the method of characteristics for initial value and initial-boundary value problems involving PDEs
- 65M30** Numerical methods for ill-posed problems for initial value and initial-boundary value problems involving PDEs
- 65M32** Numerical methods for inverse problems for initial value and initial-boundary value problems involving PDEs
- 65M38** Boundary element methods for initial value and initial-boundary value problems involving PDEs

- 65M50** Mesh generation, refinement, and adaptive methods for the numerical solution of initial value and initial-boundary value problems involving PDEs
- 65M55** Multigrid methods; domain decomposition for initial value and initial-boundary value problems involving PDEs
- 65M60** Finite element, Rayleigh-Ritz and Galerkin methods for initial value and initial-boundary value problems involving PDEs
- 65M70** Spectral, collocation and related methods for initial value and initial-boundary value problems involving PDEs
- 65M75** Probabilistic methods, particle methods, etc. for initial value and initial-boundary value problems involving PDEs
- 65M80** Fundamental solutions, Green's function methods, etc. for initial value and initial-boundary value problems involving PDEs
- 65M85** Fictitious domain methods for initial value and initial-boundary value problems involving PDEs
- 65M99** None of the above, but in this section

65Nxx Numerical methods for partial differential equations, boundary value problems

- 65N06** Finite difference methods for boundary value problems involving PDEs
- 65N08** Finite volume methods for boundary value problems involving PDEs
- 65N12** Stability and convergence of numerical methods for boundary value problems involving PDEs
- 65N15** Error bounds for boundary value problems involving PDEs
- 65N20** Numerical methods for ill-posed problems for boundary value problems involving PDEs
- 65N21** Numerical methods for inverse problems for boundary value problems involving PDEs
- 65N22** Numerical solution of discretized equations for boundary value problems involving PDEs [See also [65Fxx](#), [65Hxx](#)]
- 65N25** Numerical methods for eigenvalue problems for boundary value problems involving PDEs
- 65N30** Finite element, Rayleigh-Ritz and Galerkin methods for boundary value problems involving PDEs
- 65N35** Spectral, collocation and related methods for boundary value problems involving PDEs
- 65N38** Boundary element methods for boundary value problems involving PDEs
- 65N40** Method of lines for boundary value problems involving PDEs
- 65N45** Method of contraction of the boundary for boundary value problems involving PDEs
- 65N50** Mesh generation, refinement, and adaptive methods for boundary value problems involving PDEs
- 65N55** Multigrid methods; domain decomposition for boundary value problems involving PDEs
- 65N75** Probabilistic methods, particle methods, etc. for boundary value problems involving PDEs
- 65N80** Fundamental solutions, Green's function methods, etc. for boundary value problems involving PDEs
- 65N85** Fictitious domain methods for boundary value problems involving PDEs
- 65N99** None of the above, but in this section

65Pxx Numerical problems in dynamical systems [See also [37Mxx](#)]

65P10 Numerical methods for Hamiltonian systems including symplectic integrators

65P20 Numerical chaos

65P30 Numerical bifurcation problems

65P40 Numerical nonlinear stabilities in dynamical systems

65P99 None of the above, but in this section

65Qxx Numerical methods for difference and functional equations, recurrence relations

65Q10 Numerical methods for difference equations

65Q20 Numerical methods for functional equations

65Q30 Numerical aspects of recurrence relations

65Q99 None of the above, but in this section

65Rxx Numerical methods for integral equations, integral transforms

65R10 Numerical methods for integral transforms

65R15 Numerical methods for eigenvalue problems in integral equations

65R20 Numerical methods for integral equations

65R30 Numerical methods for ill-posed problems for integral equations

65R32 Numerical methods for inverse problems for integral equations

65R99 None of the above, but in this section

65Sxx Graphical methods in numerical analysis

65S05 Graphical methods in numerical analysis

65S99 None of the above, but in this section

65Txx Numerical methods in Fourier analysis

65T40 Numerical methods for trigonometric approximation and interpolation

65T50 Numerical methods for discrete and fast Fourier transforms

65T60 Numerical methods for wavelets

65T99 None of the above, but in this section

65Yxx Computer aspects of numerical algorithms

65Y04 Numerical algorithms for computer arithmetic, etc. [See also [68M07](#)]

65Y05 Parallel numerical computation

65Y10 Numerical algorithms for specific classes of architectures

65Y15 Packaged methods for numerical algorithms

65Y20 Complexity and performance of numerical algorithms [See also [68Q25](#)]

65Y99 None of the above, but in this section

65Zxx Applications to the sciences

65Z05 Applications to the sciences

65Z99 None of the above, but in this section

68-XX Computer science {For papers containing software, source code, etc. in a specific mathematical area, see the classification number -04 in that area}

68-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to computer science

68-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to computer science

68-02 Research exposition (monographs, survey articles) pertaining to computer science

68-03 History of computer science [Consider also classification numbers pertaining to Section [01](#)]

68-04 Software, source code, etc. for problems pertaining to computer science

68-06 Proceedings, conferences, collections, etc. pertaining to computer science

68-11 Research data for problems pertaining to computer science

68Mxx Computer system organization

68M01 General theory of computer systems

68M07 Mathematical problems of computer architecture [See also [68W35](#)]

68M10 Network design and communication in computer systems [See also [68R10](#), [90B18](#)]

68M11 Internet topics [See also [68U35](#)]

68M12 Network protocols

68M14 Distributed systems

68M15 Reliability, testing and fault tolerance of networks and computer systems

68M18 Wireless sensor networks as related to computer science [See also [90B18](#), [90B80](#)]

68M20 Performance evaluation, queueing, and scheduling in the context of computer systems [See also [60K20](#), [60K25](#), [90B22](#), [90B35](#), [90B36](#)]

68M25 Computer security

68M99 None of the above, but in this section

68Nxx Theory of software

68N01 General topics in the theory of software

68N15 Theory of programming languages

68N17 Logic programming

68N18 Functional programming and lambda calculus [See also [03B40](#)]

68N19 Other programming paradigms (object-oriented, sequential, concurrent, automatic, etc.)

- 68N20 Theory of compilers and interpreters
- 68N25 Theory of operating systems
- 68N30 Mathematical aspects of software engineering (specification, verification, metrics, requirements, etc.)
- 68N99 None of the above, but in this section

68Pxx Theory of data

- 68P01 General topics in the theory of data
- 68P05 Data structures
- 68P10 Searching and sorting
- 68P15 Database theory
- 68P20 Information storage and retrieval of data
- 68P25 Data encryption (aspects in computer science) [See also [81P94](#), [94A60](#)]
- 68P27 Privacy of data
- 68P30 Coding and information theory (compaction, compression, models of communication, encoding schemes, etc.) (aspects in computer science) [See also [94Axx](#), [94Bxx](#)]
- 68P99 None of the above, but in this section

68Qxx Theory of computing

- 68Q01 General topics in the theory of computing
- 68Q04 Classical models of computation (Turing machines, etc.) [See also [03D10](#)]
- 68Q06 Networks and circuits as models of computation; circuit complexity [See also [94C11](#)]
- 68Q07 Biologically inspired models of computation (DNA computing, membrane computing, etc.)
- 68Q09 Other nonclassical models of computation {For quantum computing, see mainly [68Q12](#), [81P68](#)}
- 68Q10 Modes of computation (nondeterministic, parallel, interactive, probabilistic, etc.) [See also [68Q85](#)]
- 68Q11 Communication complexity, information complexity
- 68Q12 Quantum algorithms and complexity in the theory of computing [See also [68Q09](#), [81P68](#)]
- 68Q15 Complexity classes (hierarchies, relations among complexity classes, etc.) [See also [03D15](#), [68Q17](#), [68Q19](#)]
- 68Q17 Computational difficulty of problems (lower bounds, completeness, difficulty of approximation, etc.) [See also [68Q15](#)]
- 68Q19 Descriptive complexity and finite models [See also [03C13](#)]
- 68Q25 Analysis of algorithms and problem complexity [See also [68W40](#)]
- 68Q27 Parameterized complexity, tractability and kernelization
- 68Q30 Algorithmic information theory (Kolmogorov complexity, etc.) [See also [03D32](#)]
- 68Q32 Computational learning theory [See also [68T05](#)]
- 68Q42 Grammars and rewriting systems

- 68Q45** Formal languages and automata [See also [03D05](#), [68Q70](#), [94A45](#)]
- 68Q55** Semantics in the theory of computing [See also [03B70](#), [06B35](#), [18C50](#)]
- 68Q60** Specification and verification (program logics, model checking, etc.) [See also [03B70](#)]
- 68Q65** Abstract data types; algebraic specification [See also [18C50](#)]
- 68Q70** Algebraic theory of languages and automata [See also [18B20](#), [20M35](#)]
- 68Q80** Cellular automata (computational aspects) {For cellular automata as dynamical systems, see [37B15](#)}
- 68Q85** Models and methods for concurrent and distributed computing (process algebras, bisimulation, transition nets, etc.)
- 68Q87** Probability in computer science (algorithm analysis, random structures, phase transitions, etc.) [See also [68W20](#), [68W40](#)]
- 68Q99** None of the above, but in this section

68Rxx Discrete mathematics in relation to computer science

- 68R01** General topics of discrete mathematics in relation to computer science
- 68R05** Combinatorics in computer science
- 68R07** Computational aspects of satisfiability [See also [68T20](#)]
- 68R10** Graph theory (including graph drawing) in computer science [See also [05Cxx](#), [90B10](#), [90C35](#)]
- 68R12** Metric embeddings as related to computational problems and algorithms
- 68R15** Combinatorics on words
- 68R99** None of the above, but in this section

68Txx Artificial intelligence

- 68T01** General topics in artificial intelligence
- 68T05** Learning and adaptive systems in artificial intelligence [See also [68Q32](#)]
- 68T07** Artificial neural networks and deep learning
- 68T09** Computational aspects of data analysis and big data [See also [62R07](#)] {For homological aspects, see [55N31](#)}
- 68T10** Pattern recognition, speech recognition {For cluster analysis, see [62H30](#)}
- 68T20** Problem solving in the context of artificial intelligence (heuristics, search strategies, etc.)
- 68T27** Logic in artificial intelligence
- 68T30** Knowledge representation
- 68T35** Theory of languages and software systems (knowledge-based systems, expert systems, etc.) for artificial intelligence
- 68T37** Reasoning under uncertainty in the context of artificial intelligence
- 68T40** Artificial intelligence for robotics [See also [93C85](#)]
- 68T42** Agent technology and artificial intelligence
- 68T45** Machine vision and scene understanding
- 68T50** Natural language processing [See also [03B65](#), [91F20](#)]
- 68T99** None of the above, but in this section

68Uxx Computing methodologies and applications

68U01 General topics in computing methodologies

68U03 Computational aspects of digital topology {For topological aspects, see [54H30](#); for homological aspects, see [55-XX](#)}

68U05 Computer graphics; computational geometry (digital and algorithmic aspects) {For methods of numerical mathematics, see [65D18](#)}

68U07 Computer science aspects of computer-aided design {For methods of numerical mathematics, see [65D17](#)}

68U10 Computing methodologies for image processing

68U15 Computing methodologies for text processing; mathematical typography

68U35 Computing methodologies for information systems (hypertext navigation, interfaces, decision support, etc.) [See also [68M11](#)]

68U99 None of the above, but in this section

68Vxx Computer science support for mathematical research and practice

68V05 Computer assisted proofs of proofs-by-exhaustion type {For rigorous numerics, see [65Gxx](#); for proofs employing automated or interactive theorem provers, see [68V15](#)}

68V15 Theorem proving (automated and interactive theorem provers, deduction, resolution, etc.) [See also [03B35](#)]

68V20 Formalization of mathematics in connection with theorem provers [See also [03B35](#), [68V15](#)]

68V25 Presentation and content markup for mathematics

68V30 Mathematical knowledge management

68V35 Digital mathematics libraries and repositories

68V99 None of the above, but in this section

68Wxx Algorithms in computer science {For numerical algorithms, see [65-XX](#); for combinatorics and graph theory, see [05C85](#), [68Rxx](#)}

68W01 General topics in the theory of algorithms

68W05 Nonnumerical algorithms

68W10 Parallel algorithms in computer science

68W15 Distributed algorithms

68W20 Randomized algorithms

68W25 Approximation algorithms

68W27 Online algorithms; streaming algorithms

68W30 Symbolic computation and algebraic computation [See also [11Yxx](#), [12-08](#), [13Pxx](#), [14Qxx](#), [16Z05](#), [17-08](#), [33F10](#)]

68W32 Algorithms on strings

68W35 Hardware implementations of nonnumerical algorithms (VLSI algorithms, etc.) [See also [68M07](#)]

68W40 Analysis of algorithms [See also [68Q25](#)]

68W50 Evolutionary algorithms, genetic algorithms (computational aspects) [See also [68T05](#), [68T20](#), [90C59](#)]

68W99 None of the above, but in this section

70-XX Mechanics of particles and systems {For relativistic mechanics, see [83A05](#), [83C10](#); for statistical mechanics, see [82-XX](#)}

70-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to mechanics of particles and systems

70-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to mechanics of particles and systems

70-02 Research exposition (monographs, survey articles) pertaining to mechanics of particles and systems

70-03 History of mechanics of particles and systems [Consider also classification numbers pertaining to [Section 01](#)]

70-04 Software, source code, etc. for problems pertaining to mechanics of particles and systems

70-05 Experimental work for problems pertaining to mechanics of particles and systems

70-06 Proceedings, conferences, collections, etc. pertaining to mechanics of particles and systems

70-08 Computational methods for problems pertaining to mechanics of particles and systems

70-10 Mathematical modeling or simulation for problems pertaining to mechanics of particles and systems

70-11 Research data for problems pertaining to mechanics of particles and systems

70Axx Axiomatics, foundations

70A05 Axiomatics, foundations

70A99 None of the above, but in this section

70Bxx Kinematics [See also [53A17](#)]

70B05 Kinematics of a particle

70B10 Kinematics of a rigid body

70B15 Kinematics of mechanisms and robots [See also [68T40](#), [70Q05](#), [93C85](#)]

70B99 None of the above, but in this section

70Cxx Statics

70C20 Statics

70C99 None of the above, but in this section

70Exx Dynamics of a rigid body and of multibody systems

70E05 Motion of the gyroscope

70E15 Free motion of a rigid body [See also [70M20](#)]

70E17 Motion of a rigid body with a fixed point

70E18 Motion of a rigid body in contact with a solid surface [See also [70F25](#)]

70E20 Perturbation methods for rigid body dynamics

70E40 Integrable cases of motion in rigid body dynamics

70E45 Higher-dimensional generalizations in rigid body dynamics

70E50 Stability problems in rigid body dynamics

70E55 Dynamics of multibody systems

70E60 Robot dynamics and control of rigid bodies [See also [68T40](#), [70Q05](#), [93C85](#)]

70E99 None of the above, but in this section

70Fxx Dynamics of a system of particles, including celestial mechanics

70F05 Two-body problems

70F07 Three-body problems

70F10 n -body problems

70F15 Celestial mechanics

70F16 Collisions in celestial mechanics, regularization

70F17 Inverse problems for systems of particles

70F20 Holonomic systems related to the dynamics of a system of particles

70F25 Nonholonomic systems related to the dynamics of a system of particles

70F35 Collision of rigid or pseudo-rigid bodies

70F40 Problems involving a system of particles with friction

70F45 The dynamics of infinite particle systems

70F99 None of the above, but in this section

70Gxx General models, approaches, and methods [See also [37-XX](#)]

70G10 Generalized coordinates; event, impulse-energy, configuration, state, or phase space for problems in mechanics

70G40 Topological and differential topological methods for problems in mechanics

70G45 Differential geometric methods (tensors, connections, symplectic, Poisson, contact, Riemannian, nonholonomic, etc.) for problems in mechanics [See also [53Cxx](#), [53Dxx](#), [58Axx](#)]

70G55 Algebraic geometry methods for problems in mechanics

70G60 Dynamical systems methods for problems in mechanics

70G65 Symmetries, Lie group and Lie algebra methods for problems in mechanics

70G70 Functional analytic methods for problems in mechanics

70G75 Variational methods for problems in mechanics

70G99 None of the above, but in this section

70Hxx Hamiltonian and Lagrangian mechanics [See also [37Jxx](#)]

70H03 Lagrange's equations

70H05 Hamilton's equations

70H06 Completely integrable systems and methods of integration for problems in Hamiltonian and Lagrangian mechanics

70H07 Nonintegrable systems for problems in Hamiltonian and Lagrangian mechanics

70H08 Nearly integrable Hamiltonian systems, KAM theory

70H09 Perturbation theories for problems in Hamiltonian and Lagrangian mechanics

70H11 Adiabatic invariants for problems in Hamiltonian and Lagrangian mechanics

70H12 Periodic and almost periodic solutions for problems in Hamiltonian and Lagrangian mechanics

70H14 Stability problems for problems in Hamiltonian and Lagrangian mechanics

70H15 Canonical and symplectic transformations for problems in Hamiltonian and Lagrangian mechanics

70H20 Hamilton-Jacobi equations in mechanics

70H25 Hamilton's principle

70H30 Other variational principles in mechanics

70H33 Symmetries and conservation laws, reverse symmetries, invariant manifolds and their bifurcations, reduction for problems in Hamiltonian and Lagrangian mechanics

70H40 Relativistic dynamics for problems in Hamiltonian and Lagrangian mechanics

70H45 Constrained dynamics, Dirac's theory of constraints [See also [70F20](#), [70F25](#), [70Gxx](#)]

70H50 Higher-order theories for problems in Hamiltonian and Lagrangian mechanics

70H99 None of the above, but in this section

70Jxx Linear vibration theory

70J10 Modal analysis in linear vibration theory

70J25 Stability for problems in linear vibration theory

70J30 Free motions in linear vibration theory

70J35 Forced motions in linear vibration theory

70J40 Parametric resonances in linear vibration theory

70J50 Systems arising from the discretization of structural vibration problems

70J99 None of the above, but in this section

70Kxx Nonlinear dynamics in mechanics [See also [34Cxx](#), [37-XX](#)]

70K05 Phase plane analysis, limit cycles for nonlinear problems in mechanics

70K20 Stability for nonlinear problems in mechanics

70K25 Free motions for nonlinear problems in mechanics

70K28 Parametric resonances for nonlinear problems in mechanics

70K30 Nonlinear resonances for nonlinear problems in mechanics

70K40 Forced motions for nonlinear problems in mechanics

70K42 Equilibria and periodic trajectories for nonlinear problems in mechanics

70K43 Quasi-periodic motions and invariant tori for nonlinear problems in mechanics

70K44 Homoclinic and heteroclinic trajectories for nonlinear problems in mechanics

70K45 Normal forms for nonlinear problems in mechanics

70K50 Bifurcations and instability for nonlinear problems in mechanics

70K55 Transition to stochasticity (chaotic behavior) for nonlinear problems in mechanics [See also [37D45](#)]

70K60 General perturbation schemes for nonlinear problems in mechanics

70K65 Averaging of perturbations for nonlinear problems in mechanics

70K70 Systems with slow and fast motions for nonlinear problems in mechanics

70K75 Nonlinear modes

70K99 None of the above, but in this section

70Lxx Random and stochastic aspects of the mechanics of particles and systems

70L05 Random vibrations in mechanics of particles and systems [See also [74H50](#)]

70L10 Stochastic geometric mechanics

70L99 None of the above, but in this section

70Mxx Orbital mechanics

70M20 Orbital mechanics

70M99 None of the above, but in this section

70Pxx Variable mass, rockets

70P05 Variable mass, rockets

70P99 None of the above, but in this section

70Qxx Control of mechanical systems [See also [60Gxx](#), [60Jxx](#)]

70Q05 Control of mechanical systems

70Q99 None of the above, but in this section

70Sxx Classical field theories [See also [37Kxx](#), [37Lxx](#), [78-XX](#), [81Txx](#), [83-XX](#)]

70S05 Lagrangian formalism and Hamiltonian formalism in mechanics of particles and systems

70S10 Symmetries and conservation laws in mechanics of particles and systems

70S15 Yang-Mills and other gauge theories in mechanics of particles and systems

70S20 More general nonquantum field theories in mechanics of particles and systems

70S99 None of the above, but in this section

74-XX Mechanics of deformable solids

74-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to mechanics of deformable solids

74-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to mechanics of deformable solids

74-02 Research exposition (monographs, survey articles) pertaining to mechanics of deformable solids

74-03 History of mechanics of deformable solids [Consider also classification numbers pertaining to [Section 01](#)]

74-04 Software, source code, etc. for problems pertaining to mechanics of deformable solids

74-05 Experimental work for problems pertaining to mechanics of deformable solids

74-06 Proceedings, conferences, collections, etc. pertaining to mechanics of deformable solids

74-10 Mathematical modeling or simulation for problems pertaining to mechanics of deformable solids

74-11 Research data for problems pertaining to mechanics of deformable solids

74Axx Generalities, axiomatics, foundations of continuum mechanics of solids

74A05 Kinematics of deformation

74A10 Stress

74A15 Thermodynamics in solid mechanics

74A20 Theory of constitutive functions in solid mechanics

74A25 Molecular, statistical, and kinetic theories in solid mechanics

74A30 Nonsimple materials

74A35 Polar materials

74A40 Random materials and composite materials

74A45 Theories of fracture and damage

74A50 Structured surfaces and interfaces, coexistent phases

74A55 Theories of friction (tribology)

74A60 Micromechanical theories

74A65 Reactive materials

74A70 Peridynamics

74A99 None of the above, but in this section

74Bxx Elastic materials

74B05 Classical linear elasticity

74B10 Linear elasticity with initial stresses

74B15 Equations linearized about a deformed state (small deformations superposed on large)

74B20 Nonlinear elasticity

74B99 None of the above, but in this section

74Cxx Plastic materials, materials of stress-rate and internal-variable type

74C05 Small-strain, rate-independent theories of plasticity (including rigid-plastic and elasto-plastic materials)

74C10 Small-strain, rate-dependent theories of plasticity (including theories of viscoplasticity)

74C15 Large-strain, rate-independent theories of plasticity (including nonlinear plasticity)

74C20 Large-strain, rate-dependent theories of plasticity

74C99 None of the above, but in this section

74Dxx Materials of strain-rate type and history type, other materials with memory (including elastic materials with viscous damping, various viscoelastic materials)

74D05 Linear constitutive equations for materials with memory

74D10 Nonlinear constitutive equations for materials with memory

74D99 None of the above, but in this section

74Exx Material properties given special treatment

74E05 Inhomogeneity in solid mechanics

74E10 Anisotropy in solid mechanics

74E15 Crystalline structure

74E20 Granularity

74E25 Texture in solid mechanics

74E30 Composite and mixture properties

74E35 Random structure in solid mechanics

74E40 Chemical structure in solid mechanics

74E99 None of the above, but in this section

74Fxx Coupling of solid mechanics with other effects

74F05 Thermal effects in solid mechanics

74F10 Fluid-solid interactions (including aero- and hydro-elasticity, porosity, etc.)

74F15 Electromagnetic effects in solid mechanics

74F20 Mixture effects in solid mechanics

74F25 Chemical and reactive effects in solid mechanics

74F99 None of the above, but in this section

74Gxx Equilibrium (steady-state) problems in solid mechanics

- 74G05 Explicit solutions of equilibrium problems in solid mechanics
- 74G10 Analytic approximation of solutions (perturbation methods, asymptotic methods, series, etc.) of equilibrium problems in solid mechanics
- 74G15 Numerical approximation of solutions of equilibrium problems in solid mechanics
- 74G25 Existence of solutions of equilibrium problems in solid mechanics
- 74G30 Uniqueness of solutions of equilibrium problems in solid mechanics
- 74G35 Multiplicity of solutions of equilibrium problems in solid mechanics
- 74G40 Regularity of solutions of equilibrium problems in solid mechanics
- 74G45 Bounds for solutions of equilibrium problems in solid mechanics
- 74G50 Saint-Venant's principle
- 74G55 Qualitative behavior of solutions of equilibrium problems in solid mechanics
- 74G60 Bifurcation and buckling
- 74G65 Energy minimization in equilibrium problems in solid mechanics
- 74G70 Stress concentrations, singularities in solid mechanics
- 74G75 Inverse problems in equilibrium solid mechanics
- 74G99 None of the above, but in this section

74Hxx Dynamical problems in solid mechanics

- 74H05 Explicit solutions of dynamical problems in solid mechanics
- 74H10 Analytic approximation of solutions (perturbation methods, asymptotic methods, series, etc.) of dynamical problems in solid mechanics
- 74H15 Numerical approximation of solutions of dynamical problems in solid mechanics
- 74H20 Existence of solutions of dynamical problems in solid mechanics
- 74H25 Uniqueness of solutions of dynamical problems in solid mechanics
- 74H30 Regularity of solutions of dynamical problems in solid mechanics
- 74H35 Singularities, blow-up, stress concentrations for dynamical problems in solid mechanics
- 74H40 Long-time behavior of solutions for dynamical problems in solid mechanics
- 74H45 Vibrations in dynamical problems in solid mechanics
- 74H50 Random vibrations in dynamical problems in solid mechanics
- 74H55 Stability of dynamical problems in solid mechanics
- 74H60 Dynamical bifurcation of solutions to dynamical problems in solid mechanics
- 74H65 Chaotic behavior of solutions to dynamical problems in solid mechanics
- 74H75 Inverse problems in dynamical solid mechanics
- 74H80 Energy minimization in dynamical problems in solid mechanics
- 74H99 None of the above, but in this section

74Jxx Waves in solid mechanics

- 74J05** Linear waves in solid mechanics
- 74J10** Bulk waves in solid mechanics
- 74J15** Surface waves in solid mechanics
- 74J20** Wave scattering in solid mechanics
- 74J25** Inverse problems for waves in solid mechanics
- 74J30** Nonlinear waves in solid mechanics
- 74J35** Solitary waves in solid mechanics
- 74J40** Shocks and related discontinuities in solid mechanics
- 74J99** None of the above, but in this section

74Kxx Thin bodies, structures

- 74K05** Strings
- 74K10** Rods (beams, columns, shafts, arches, rings, etc.)
- 74K15** Membranes
- 74K20** Plates
- 74K25** Shells
- 74K30** Junctions
- 74K35** Thin films
- 74K99** None of the above, but in this section

74Lxx Special subfields of solid mechanics

- 74L05** Geophysical solid mechanics [See also [86-XX](#)]
- 74L10** Soil and rock mechanics
- 74L15** Biomechanical solid mechanics [See also [92C10](#)]
- 74L99** None of the above, but in this section

74Mxx Special kinds of problems in solid mechanics

- 74M05** Control, switches and devices (“smart materials”) in solid mechanics [See also [93Cxx](#)]
- 74M10** Friction in solid mechanics
- 74M15** Contact in solid mechanics
- 74M20** Impact in solid mechanics
- 74M25** Micromechanics of solids
- 74M99** None of the above, but in this section

74Nxx Phase transformations in solids [See also [74A50](#), [80Axx](#), [82B26](#), [82C26](#)]

74N05 Crystals in solids

74N10 Displacive transformations in solids

74N15 Analysis of microstructure in solids

74N20 Dynamics of phase boundaries in solids

74N25 Transformations involving diffusion in solids

74N30 Problems involving hysteresis in solids

74N99 None of the above, but in this section

74Pxx Optimization problems in solid mechanics [See also [49Qxx](#)]

74P05 Compliance or weight optimization in solid mechanics

74P10 Optimization of other properties in solid mechanics

74P15 Topological methods for optimization problems in solid mechanics

74P20 Geometrical methods for optimization problems in solid mechanics

74P99 None of the above, but in this section

74Qxx Homogenization, determination of effective properties in solid mechanics

74Q05 Homogenization in equilibrium problems of solid mechanics

74Q10 Homogenization and oscillations in dynamical problems of solid mechanics

74Q15 Effective constitutive equations in solid mechanics

74Q20 Bounds on effective properties in solid mechanics

74Q99 None of the above, but in this section

74Rxx Fracture and damage

74R05 Brittle damage

74R10 Brittle fracture

74R15 High-velocity fracture

74R20 Anelastic fracture and damage

74R99 None of the above, but in this section

74Sxx Numerical and other methods in solid mechanics [See also [65-XX](#), [74G15](#), [74H15](#)]

- 74S05 Finite element methods applied to problems in solid mechanics
- 74S10 Finite volume methods applied to problems in solid mechanics
- 74S15 Boundary element methods applied to problems in solid mechanics
- 74S20 Finite difference methods applied to problems in solid mechanics
- 74S22 Isogeometric methods applied to problems in solid mechanics
- 74S25 Spectral and related methods applied to problems in solid mechanics
- 74S30 Other numerical methods applied to problems in solid mechanics
- 74S40 Applications of fractional calculus in solid mechanics
- 74S50 Applications of graph theory in solid mechanics
- 74S60 Stochastic and other probabilistic methods applied to problems in solid mechanics
- 74S70 Complex-variable methods applied to problems in solid mechanics
- 74S99 None of the above, but in this section

76-XX Fluid mechanics {For general continuum mechanics, see [74Axx](#), or other parts of [74-XX](#)}

- 76-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to fluid mechanics
- 76-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to fluid mechanics
- 76-02 Research exposition (monographs, survey articles) pertaining to fluid mechanics
- 76-03 History of fluid mechanics [Consider also classification numbers pertaining to Section [01](#)]
- 76-04 Software, source code, etc. for problems pertaining to fluid mechanics
- 76-05 Experimental work for problems pertaining to fluid mechanics
- 76-06 Proceedings, conferences, collections, etc. pertaining to fluid mechanics
- 76-10 Mathematical modeling or simulation for problems pertaining to fluid mechanics
- 76-11 Research data for problems pertaining to fluid mechanics

76Axx Foundations, constitutive equations, rheology, hydrodynamical models of non-fluid phenomena

- 76A02 Foundations of fluid mechanics
- 76A05 Non-Newtonian fluids
- 76A10 Viscoelastic fluids
- 76A15 Liquid crystals [See also [82D30](#)]
- 76A20 Thin fluid films
- 76A25 Superfluids (classical aspects)
- 76A30 Traffic and pedestrian flow models
- 76A99 None of the above, but in this section

76Bxx Incompressible inviscid fluids

- 76B03** Existence, uniqueness, and regularity theory for incompressible inviscid fluids [See also [35Q35](#)]
- 76B07** Free-surface potential flows for incompressible inviscid fluids
- 76B10** Jets and cavities, cavitation, free-streamline theory, water-entry problems, airfoil and hydrofoil theory, sloshing
- 76B15** Water waves, gravity waves; dispersion and scattering, nonlinear interaction [See also [35Q30](#)]
- 76B20** Ship waves
- 76B25** Solitary waves for incompressible inviscid fluids [See also [35C11](#)]
- 76B45** Capillarity (surface tension) for incompressible inviscid fluids [See also [76D45](#)]
- 76B47** Vortex flows for incompressible inviscid fluids
- 76B55** Internal waves for incompressible inviscid fluids
- 76B70** Stratification effects in inviscid fluids
- 76B75** Flow control and optimization for incompressible inviscid fluids [See also [49Q10](#), [93C20](#), [93C95](#)]
- 76B99** None of the above, but in this section

76Dxx Incompressible viscous fluids

- 76D03** Existence, uniqueness, and regularity theory for incompressible viscous fluids [See also [35Q30](#)]
- 76D05** Navier-Stokes equations for incompressible viscous fluids [See also [35Q30](#)]
- 76D06** Statistical solutions of Navier-Stokes and related equations [See also [60H30](#), [76M35](#)]
- 76D07** Stokes and related (Oseen, etc.) flows
- 76D08** Lubrication theory
- 76D09** Viscous-inviscid interaction
- 76D10** Boundary-layer theory, separation and reattachment, higher-order effects
- 76D17** Viscous vortex flows
- 76D25** Wakes and jets
- 76D27** Other free boundary flows; Hele-Shaw flows
- 76D33** Waves for incompressible viscous fluids
- 76D45** Capillarity (surface tension) for incompressible viscous fluids [See also [76B45](#)]
- 76D50** Stratification effects in viscous fluids
- 76D55** Flow control and optimization for incompressible viscous fluids [See also [49Q10](#), [93C20](#), [93C95](#)]
- 76D99** None of the above, but in this section

76Exx Hydrodynamic stability

76E05 Parallel shear flows in hydrodynamic stability

76E06 Convection in hydrodynamic stability

76E07 Rotation in hydrodynamic stability

76E09 Stability and instability of nonparallel flows in hydrodynamic stability

76E15 Absolute and convective instability and stability in hydrodynamic stability

76E17 Interfacial stability and instability in hydrodynamic stability

76E19 Compressibility effects in hydrodynamic stability

76E20 Stability and instability of geophysical and astrophysical flows

76E25 Stability and instability of magnetohydrodynamic and electrohydrodynamic flows

76E30 Nonlinear effects in hydrodynamic stability

76E99 None of the above, but in this section

76Fxx Turbulence [See also [37-XX](#), [60Gxx](#), [60Jxx](#)]

76F02 Fundamentals of turbulence

76F05 Isotropic turbulence; homogeneous turbulence

76F06 Transition to turbulence

76F10 Shear flows and turbulence

76F20 Dynamical systems approach to turbulence [See also [37-XX](#)]

76F25 Turbulent transport, mixing

76F30 Renormalization and other field-theoretical methods for turbulence [See also [81T99](#)]

76F35 Convective turbulence [See also [76E15](#), [76Rxx](#)]

76F40 Turbulent boundary layers

76F45 Stratification effects in turbulence

76F50 Compressibility effects in turbulence

76F55 Statistical turbulence modeling [See also [76M35](#)]

76F60 k - ε modeling in turbulence

76F65 Direct numerical and large eddy simulation of turbulence

76F70 Control of turbulent flows

76F80 Turbulent combustion; reactive turbulence

76F99 None of the above, but in this section

76Gxx General aerodynamics and subsonic flows

76G25 General aerodynamics and subsonic flows

76G99 None of the above, but in this section

76Hxx Transonic flows

76H05 Transonic flows

76H99 None of the above, but in this section

76Jxx Supersonic flows

76J20 Supersonic flows

76J99 None of the above, but in this section

76Kxx Hypersonic flows

76K05 Hypersonic flows

76K99 None of the above, but in this section

76Lxx Shock waves and blast waves in fluid mechanics [See also [35L67](#)]

76L05 Shock waves and blast waves in fluid mechanics [See also [35L67](#)]

76L99 None of the above, but in this section

76Mxx Basic methods in fluid mechanics [See also [65-XX](#)]

76M10 Finite element methods applied to problems in fluid mechanics

76M12 Finite volume methods applied to problems in fluid mechanics

76M15 Boundary element methods applied to problems in fluid mechanics

76M20 Finite difference methods applied to problems in fluid mechanics

76M21 Inverse problems in fluid mechanics

76M22 Spectral methods applied to problems in fluid mechanics

76M23 Vortex methods applied to problems in fluid mechanics

76M25 Other numerical methods applied to problems in fluid mechanics

76M27 Visualization algorithms applied to problems in fluid mechanics

76M28 Particle methods and lattice-gas methods

76M30 Variational methods applied to problems in fluid mechanics

76M35 Stochastic analysis applied to problems in fluid mechanics

76M40 Complex variables methods applied to problems in fluid mechanics

76M45 Asymptotic methods, singular perturbations applied to problems in fluid mechanics

76M50 Homogenization applied to problems in fluid mechanics

76M55 Dimensional analysis and similarity applied to problems in fluid mechanics

76M60 Symmetry analysis, Lie group and Lie algebra methods applied to problems in fluid mechanics

76M99 None of the above, but in this section

76Nxx Compressible fluids and gas dynamics, general

76N05 Compressible Navier-Stokes equations

76N10 Existence, uniqueness, and regularity theory for compressible fluids and gas dynamics [See also [35L60](#), [35L65](#), [35Q30](#)]

76N15 Gas dynamics, general

76N17 Viscous-inviscid interaction for compressible fluids and gas dynamics

76N20 Boundary-layer theory for compressible fluids and gas dynamics

76N25 Flow control and optimization for compressible fluids and gas dynamics

76N30 Waves in compressible fluids

76N99 None of the above, but in this section

76Pxx Rarefied gas flows, Boltzmann equation in fluid mechanics [See also [82B40](#), [82C40](#), [82D05](#)]

76P05 Rarefied gas flows, Boltzmann equation in fluid mechanics [See also [82B40](#), [82C40](#), [82D05](#)]

76P99 None of the above, but in this section

76Qxx Hydro- and aero-acoustics

76Q05 Hydro- and aero-acoustics

76Q99 None of the above, but in this section

76Rxx Diffusion and convection

76R05 Forced convection

76R10 Free convection

76R50 Diffusion [See also [60J60](#)]

76R99 None of the above, but in this section

76Sxx Flows in porous media; filtration; seepage

76S05 Flows in porous media; filtration; seepage

76S99 None of the above, but in this section

76Txx Multiphase and multicomponent flows

76T05 Liquid-liquid two component flows

76T10 Liquid-gas two-phase flows, bubbly flows

76T15 Dusty-gas two-phase flows

76T17 Two gas multicomponent flows

76T20 Suspensions

76T25 Granular flows [See also [74C99](#), [74E20](#)]

76T30 Three or more component flows

76T99 None of the above, but in this section

76Uxx Rotating fluids

76U05 Rotating fluids

76U60 Geophysical flows [See also [86A05](#), [86A10](#)]

76U65 Rossby waves [See also [86A05](#), [86A10](#)]

76U99 None of the above, but in this section

76Vxx Reaction effects in flows [See also [80A32](#)]

76V05 Reaction effects in flows [See also [80A32](#)]

76V99 None of the above, but in this section

76Wxx Magnetohydrodynamics and electrohydrodynamics

76W05 Magnetohydrodynamics and electrohydrodynamics

76W99 None of the above, but in this section

76Xxx Ionized gas flow in electromagnetic fields; plasmic flow [See also [82D10](#)]

76X05 Ionized gas flow in electromagnetic fields; plasmic flow [See also [82D10](#)]

76X99 None of the above, but in this section

76Yxx Quantum hydrodynamics and relativistic hydrodynamics [See also [82D50](#), [83C55](#), [85A30](#)]

76Y05 Quantum hydrodynamics and relativistic hydrodynamics [See also [82D50](#), [83C55](#), [85A30](#)]

76Y99 None of the above, but in this section

76Zxx Biological fluid mechanics [See also [74F10](#), [74L15](#), [92Cxx](#)]

76Z05 Physiological flows [See also [92C35](#)]

76Z10 Biopropulsion in water and in air

76Z99 None of the above, but in this section

78-XX Optics, electromagnetic theory {For quantum optics, see [81V80](#)}

78-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to optics and electromagnetic theory

78-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to optics and electromagnetic theory

78-02 Research exposition (monographs, survey articles) pertaining to optics and electromagnetic theory

78-03 History of optics and electromagnetic theory [Consider also classification numbers pertaining to Section [01](#)]

78-04 Software, source code, etc. for problems pertaining to optics and electromagnetic theory

78-05 Experimental work for problems pertaining to optics and electromagnetic theory

78-06 Proceedings, conferences, collections, etc. pertaining to optics and electromagnetic theory

78-10 Mathematical modeling or simulation for problems pertaining to optics and electromagnetic theory

78-11 Research data for problems pertaining to optics and electromagnetic theory

78Axx General

78A02 Foundations in optics and electromagnetic theory

78A05 Geometric optics

78A10 Physical optics

78A15 Electron optics

78A20 Space charge waves

78A25 Electromagnetic theory, general

78A30 Electro- and magnetostatics

78A35 Motion of charged particles

78A37 Ion traps

78A40 Waves and radiation in optics and electromagnetic theory

78A45 Diffraction, scattering {For WKB methods see [34E20](#)}

78A46 Inverse problems (including inverse scattering) in optics and electromagnetic theory

78A48 Composite media; random media in optics and electromagnetic theory

78A50 Antennas, waveguides in optics and electromagnetic theory

78A55 Technical applications of optics and electromagnetic theory

78A57 Electrochemistry

78A60 Lasers, masers, optical bistability, nonlinear optics [See also [81V80](#)]

78A70 Biological applications of optics and electromagnetic theory [See also [91D30](#), [92C30](#)]

78A97 Mathematically heuristic optics and electromagnetic theory (must also be assigned at least one other classification number in Section [78](#))

78A99 None of the above, but in this section

78Mxx Basic methods for problems in optics and electromagnetic theory [See also [65-XX](#)]

78M05 Method of moments applied to problems in optics and electromagnetic theory

78M10 Finite element, Galerkin and related methods applied to problems in optics and electromagnetic theory

78M12 Finite volume methods, finite integration techniques applied to problems in optics and electromagnetic theory

78M15 Boundary element methods applied to problems in optics and electromagnetic theory

78M16 Multipole methods applied to problems in optics and electromagnetic theory

78M20 Finite difference methods applied to problems in optics and electromagnetic theory

78M22 Spectral, collocation and related methods applied to problems in optics and electromagnetic theory

78M25 Other numerical methods applied to problems in optics and electromagnetic theory

78M30 Variational methods applied to problems in optics and electromagnetic theory

- 78M31 Monte Carlo methods applied to problems in optics and electromagnetic theory
- 78M32 Neural and heuristic methods applied to problems in optics and electromagnetic theory
- 78M34 Model reduction in optics and electromagnetic theory
- 78M35 Asymptotic analysis in optics and electromagnetic theory
- 78M40 Homogenization in optics and electromagnetic theory
- 78M50 Optimization problems in optics and electromagnetic theory
- 78M99 None of the above, but in this section

80-XX Classical thermodynamics, heat transfer {For thermodynamics of solids, see [74A15](#)}

- 80-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to classical thermodynamics
- 80-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to classical thermodynamics
- 80-02 Research exposition (monographs, survey articles) pertaining to classical thermodynamics
- 80-03 History of classical thermodynamics [Consider also classification numbers pertaining to Section [01](#)]
- 80-04 Software, source code, etc. for problems pertaining to classical thermodynamics
- 80-05 Experimental work for problems pertaining to classical thermodynamics
- 80-06 Proceedings, conferences, collections, etc. pertaining to classical thermodynamics
- 80-10 Mathematical modeling or simulation for problems pertaining to classical thermodynamics
- 80-11 Research data for problems pertaining to classical thermodynamics

80Axx Thermodynamics and heat transfer

- 80A05 Foundations of thermodynamics and heat transfer
- 80A10 Classical and relativistic thermodynamics
- 80A17 Thermodynamics of continua [See also [74A15](#)]
- 80A20 Diffusive and convective heat and mass transfer, heat flow
- 80A22 Stefan problems, phase changes, etc. [See also [74Nxx](#)]
- 80A23 Inverse problems in thermodynamics and heat transfer
- 80A25 Combustion
- 80A30 Chemical kinetics in thermodynamics and heat transfer [See also [76V05](#), [92C45](#), [92E20](#)]
- 80A32 Chemically reacting flows [See also [92C45](#), [92E20](#)]
- 80A50 Chemistry (general) in thermodynamics and heat transfer [See mainly [92Exx](#)]
- 80A60 Radiative heat transfer
- 80A99 None of the above, but in this section

80Mxx Basic methods in thermodynamics and heat transfer [See also [65-XX](#)]

- 80M10** Finite element, Galerkin and related methods applied to problems in thermodynamics and heat transfer
- 80M12** Finite volume methods applied to problems in thermodynamics and heat transfer
- 80M15** Boundary element methods applied to problems in thermodynamics and heat transfer
- 80M20** Finite difference methods applied to problems in thermodynamics and heat transfer
- 80M22** Spectral, collocation and related (meshless) methods applied to problems in thermodynamics and heat transfer
- 80M25** Other numerical methods applied to problems in thermodynamics and heat transfer
- 80M30** Variational methods applied to problems in thermodynamics and heat transfer
- 80M31** Monte Carlo methods applied to problems in thermodynamics and heat transfer
- 80M35** Asymptotic analysis for problems in thermodynamics and heat transfer
- 80M40** Homogenization for problems in thermodynamics and heat transfer
- 80M50** Optimization problems in thermodynamics and heat transfer
- 80M60** Stochastic analysis in thermodynamics and heat transfer
- 80M99** None of the above, but in this section

81-XX Quantum theory

- 81-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to quantum theory
- 81-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to quantum theory
- 81-02** Research exposition (monographs, survey articles) pertaining to quantum theory
- 81-03** History of quantum theory [Consider also classification numbers pertaining to Section [01](#)]
- 81-04** Software, source code, etc. for problems pertaining to quantum theory
- 81-05** Experimental work for problems pertaining to quantum theory
- 81-06** Proceedings, conferences, collections, etc. pertaining to quantum theory
- 81-08** Computational methods for problems pertaining to quantum theory
- 81-10** Mathematical modeling or simulation for problems pertaining to quantum theory
- 81-11** Research data for problems pertaining to quantum theory

81Pxx Foundations, quantum information and its processing, quantum axioms, and philosophy

- 81P05** General and philosophical questions in quantum theory
- 81P10** Logical foundations of quantum mechanics; quantum logic (quantum-theoretic aspects) [See also [03G12](#), [06C15](#)]
- 81P13** Contextuality in quantum theory
- 81P15** Quantum measurement theory, state operations, state preparations

- 81P16 Quantum state spaces, operational and probabilistic concepts
- 81P17 Quantum entropies
- 81P18 Quantum state tomography, quantum state discrimination
- 81P20 Stochastic mechanics (including stochastic electrodynamics)
- 81P40 Quantum coherence, entanglement, quantum correlations
- 81P42 Entanglement measures, concurrencies, separability criteria
- 81P43 Quantum discord
- 81P45 Quantum information, communication, networks (quantum-theoretic aspects) [See also [94A15](#), [94A17](#)]
- 81P47 Quantum channels, fidelity [See also [94A40](#)]
- 81P48 LOCC, teleportation, dense coding, remote state operations, distillation
- 81P50 Quantum state estimation, approximate cloning
- 81P55 Special bases (entangled, mutual unbiased, etc.)
- 81P65 Quantum gates
- 81P68 Quantum computation [See also [68Q09](#)] {For algorithmic aspects, see [68Q12](#)}
- 81P70 Quantum coding (general)
- 81P73 Computational stability and error-correcting codes for quantum computation and communication processing
- 81P94 Quantum cryptography (quantum-theoretic aspects) [See also [94A60](#)]
- 81P99 None of the above, but in this section

81Qxx General mathematical topics and methods in quantum theory

- 81Q05 Closed and approximate solutions to the Schrödinger, Dirac, Klein-Gordon and other equations of quantum mechanics
- 81Q10 Selfadjoint operator theory in quantum theory, including spectral analysis
- 81Q12 Nonselfadjoint operator theory in quantum theory including creation and destruction operators
- 81Q15 Perturbation theories for operators and differential equations in quantum theory
- 81Q20 Semiclassical techniques, including WKB and Maslov methods applied to problems in quantum theory
- 81Q30 Feynman integrals and graphs; applications of algebraic topology and algebraic geometry [See also [14D05](#), [32S40](#)]
- 81Q35 Quantum mechanics on special spaces: manifolds, fractals, graphs, lattices [See also [81R20](#)]
- 81Q37 Quantum dots, waveguides, ratchets, etc. [See also [82D20](#), [82D77](#)]
- 81Q40 Bethe-Salpeter and other integral equations arising in quantum theory
- 81Q50 Quantum chaos [See also [37Dxx](#)]
- 81Q60 Supersymmetry and quantum mechanics
- 81Q65 Alternative quantum mechanics (including hidden variables, etc.)

- 81Q70 differential geometric methods, including holonomy, Berry and Hannay phases, Aharonov-Bohm effect, etc. in quantum theory
- 81Q80 Special quantum systems, such as solvable systems
- 81Q93 Quantum control
- 81Q99 None of the above, but in this section

81Rxx Groups and algebras in quantum theory

- 81R05 Finite-dimensional groups and algebras motivated by physics and their representations [See also [20C35](#), [22E70](#)]
- 81R10 Infinite-dimensional groups and algebras motivated by physics, including Virasoro, Kac-Moody, W -algebras and other current algebras and their representations [See also [17B65](#), [17B67](#), [22E65](#), [22E67](#), [22E70](#)]
- 81R12 Groups and algebras in quantum theory and relations with integrable systems [See also [17Bxx](#), [37J35](#)]
- 81R15 Operator algebra methods applied to problems in quantum theory [See also [46Lxx](#), [81T05](#)]
- 81R20 Covariant wave equations in quantum theory, relativistic quantum mechanics [See also [81Q35](#)]
- 81R25 Spinor and twistor methods applied to problems in quantum theory [See also [32L25](#)]
- 81R30 Coherent states [See also [22E45](#)]; squeezed states in quantum theory [See also [81V80](#)]
- 81R40 Symmetry breaking in quantum theory
- 81R50 Quantum groups and related algebraic methods applied to problems in quantum theory [See also [16T20](#), [17B37](#)]
- 81R60 Noncommutative geometry in quantum theory
- 81R99 None of the above, but in this section

81Sxx General quantum mechanics and problems of quantization

- 81S05 Commutation relations and statistics as related to quantum mechanics (general)
- 81S07 Uncertainty relations, also entropic
- 81S08 Canonical quantization
- 81S10 Geometry and quantization, symplectic methods [See also [53D50](#)]
- 81S20 Stochastic quantization
- 81S22 Open systems, reduced dynamics, master equations, decoherence [See also [82C31](#)]
- 81S25 Quantum stochastic calculus
- 81S30 Phase-space methods including Wigner distributions, etc. applied to problems in quantum mechanics
- 81S40 Path integrals in quantum mechanics [See also [58D30](#), [81Q30](#), [81T18](#)]
- 81S99 None of the above, but in this section

- 81Txx Quantum field theory; related classical field theories** [See also [70Sxx](#)]
- 81T05** Axiomatic quantum field theory; operator algebras
 - 81T08** Constructive quantum field theory
 - 81T10** Model quantum field theories
 - 81T11** Higher spin theories
 - 81T12** Effective quantum field theories
 - 81T13** Yang-Mills and other gauge theories in quantum field theory [See also [53C07](#), [58E15](#)]
 - 81T15** Perturbative methods of renormalization applied to problems in quantum field theory
 - 81T16** Nonperturbative methods of renormalization applied to problems in quantum field theory
 - 81T17** Renormalization group methods applied to problems in quantum field theory
 - 81T18** Feynman diagrams
 - 81T20** Quantum field theory on curved space or space-time backgrounds
 - 81T25** Quantum field theory on lattices
 - 81T27** Continuum limits in quantum field theory
 - 81T28** Thermal quantum field theory [See also [82B30](#)]
 - 81T30** String and superstring theories; other extended objects (e.g., branes) in quantum field theory [See also [83E30](#)]
 - 81T32** Matrix models and tensor models for quantum field theory
 - 81T33** Dimensional compactification in quantum field theory
 - 81T35** Correspondence, duality, holography (ADS/CFT, gauge/gravity, etc.) [See also [83E05](#)]
 - 81T40** Two-dimensional field theories, conformal field theories, etc. in quantum mechanics
 - 81T45** Topological field theories in quantum mechanics [See also [57R56](#), [58Dxx](#)]
 - 81T50** Anomalies in quantum field theory
 - 81T55** Casimir effect in quantum field theory
 - 81T60** Supersymmetric field theories in quantum mechanics
 - 81T70** Quantization in field theory; cohomological methods [See also [58D29](#)]
 - 81T75** Noncommutative geometry methods in quantum field theory [See also [46L85](#), [46L87](#), [58B34](#)]
 - 81T99** None of the above, but in this section

81Uxx Quantum scattering theory [See also [34A55](#), [34L25](#), [34L40](#), [35P25](#), [47A40](#)]

81U05 2-body potential quantum scattering theory {For WKB methods, see also [34E20](#)}

81U10 n -body potential quantum scattering theory

81U15 Exactly and quasi-solvable systems arising in quantum theory

81U20 S -matrix theory, etc. in quantum theory

81U24 Resonances in quantum scattering theory

81U26 Tunneling in quantum theory

81U30 Dispersion theory, dispersion relations arising in quantum theory

81U35 Inelastic and multichannel quantum scattering

81U40 Inverse scattering problems in quantum theory

81U90 Particle decays in scattering

81U99 None of the above, but in this section

81Vxx Applications of quantum theory to specific physical systems

81V05 Strong interaction, including quantum chromodynamics

81V10 Electromagnetic interaction; quantum electrodynamics

81V15 Weak interaction in quantum theory

81V17 Gravitational interaction in quantum theory [See also [83Cxx](#), [83Exx](#)]

81V19 Other fundamental interactions in quantum theory

81V22 Unified quantum theories

81V25 Other elementary particle theory in quantum theory

81V27 Anyons

81V35 Nuclear physics

81V45 Atomic physics

81V55 Molecular physics [See also [92E10](#)]

81V60 Mono-, di- and multipole moments (EM and other), gyromagnetic relations

81V65 Quantum dots as quasi particles [See also [82D20](#)]

81V70 Many-body theory; quantum Hall effect

81V72 Particle exchange symmetries in quantum theory (general)

81V73 Bosonic systems in quantum theory

81V74 Fermionic systems in quantum theory

81V80 Quantum optics

81V99 None of the above, but in this section

82-XX Statistical mechanics, structure of matter

82-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to statistical mechanics

82-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to statistical mechanics

82-02 Research exposition (monographs, survey articles) pertaining to statistical mechanics

82-03 History of statistical mechanics [Consider also classification numbers pertaining to Section [01](#)]

82-04 Software, source code, etc. for problems pertaining to statistical mechanics

82-05 Experimental work for problems pertaining to statistical mechanics

82-06 Proceedings, conferences, collections, etc. pertaining to statistical mechanics

82-10 Mathematical modeling or simulation for problems pertaining to statistical mechanics

82-11 Research data for problems pertaining to statistical mechanics

82Bxx Equilibrium statistical mechanics

82B03 Foundations of equilibrium statistical mechanics

82B05 Classical equilibrium statistical mechanics (general)

82B10 Quantum equilibrium statistical mechanics (general)

82B20 Lattice systems (Ising, dimer, Potts, etc.) and systems on graphs arising in equilibrium statistical mechanics

82B21 Continuum models (systems of particles, etc.) arising in equilibrium statistical mechanics

82B23 Exactly solvable models; Bethe ansatz

82B24 Interface problems; diffusion-limited aggregation arising in equilibrium statistical mechanics

82B26 Phase transitions (general) in equilibrium statistical mechanics

82B27 Critical phenomena in equilibrium statistical mechanics

82B28 Renormalization group methods in equilibrium statistical mechanics [See also [81T17](#)]

82B30 Statistical thermodynamics [See also [80-XX](#)]

82B31 Stochastic methods applied to problems in equilibrium statistical mechanics

82B35 Irreversible thermodynamics, including Onsager-Machlup theory [See also [92E20](#)]

82B40 Kinetic theory of gases in equilibrium statistical mechanics

82B41 Random walks, random surfaces, lattice animals, etc. in equilibrium statistical mechanics [See also [60G50](#), [82C41](#)]

82B43 Percolation [See also [60K35](#)]

82B44 Disordered systems (random Ising models, random Schrödinger operators, etc.) in equilibrium statistical mechanics

82B99 None of the above, but in this section

82Cxx Time-dependent statistical mechanics (dynamic and nonequilibrium)

82C03 Foundations of time-dependent statistical mechanics

82C05 Classical dynamic and nonequilibrium statistical mechanics (general)

82C10 Quantum dynamics and nonequilibrium statistical mechanics (general)

82C20 Dynamic lattice systems (kinetic Ising, etc.) and systems on graphs in time-dependent statistical mechanics

82C21 Dynamic continuum models (systems of particles, etc.) in time-dependent statistical mechanics

82C22 Interacting particle systems in time-dependent statistical mechanics [See also [60K35](#)]

82C23 Exactly solvable dynamic models in time-dependent statistical mechanics [See also [37K60](#)]

82C24 Interface problems; diffusion-limited aggregation in time-dependent statistical mechanics

82C26 Dynamic and nonequilibrium phase transitions (general) in statistical mechanics

82C27 Dynamic critical phenomena in statistical mechanics

82C28 Dynamic renormalization group methods applied to problems in time-dependent statistical mechanics [See also [81T17](#)]

82C31 Stochastic methods (Fokker-Planck, Langevin, etc.) applied to problems in time-dependent statistical mechanics [See also [60H10](#)]

82C32 Neural nets applied to problems in time-dependent statistical mechanics [See also [68T05](#), [91E40](#), [92B20](#)]

82C35 Irreversible thermodynamics, including Onsager-Machlup theory

82C40 Kinetic theory of gases in time-dependent statistical mechanics

82C41 Dynamics of random walks, random surfaces, lattice animals, etc. in time-dependent statistical mechanics [See also [60G50](#)]

82C43 Time-dependent percolation in statistical mechanics [See also [60K35](#)]

82C44 Dynamics of disordered systems (random Ising systems, etc.) in time-dependent statistical mechanics

82C70 Transport processes in time-dependent statistical mechanics

82C99 None of the above, but in this section

82Dxx Applications of statistical mechanics to specific types of physical systems

82D03 Statistical mechanical studies in condensed matter (general)

82D05 Statistical mechanical studies of gases

82D10 Statistical mechanical studies of plasmas

82D15 Statistical mechanical studies of liquids

82D20 Statistical mechanical studies of solids

82D25 Statistical mechanical studies of crystals {For crystallographic group theory, see [20H15](#)}

82D30 Statistical mechanical studies of random media, disordered materials (including liquid crystals and spin glasses)

82D35 Statistical mechanical studies of metals

- 82D37** Statistical mechanical studies of semiconductors
- 82D40** Statistical mechanical studies of magnetic materials
- 82D45** Statistical mechanical studies of ferroelectrics
- 82D50** Statistical mechanical studies of superfluids
- 82D55** Statistical mechanical studies of superconductors
- 82D60** Statistical mechanical studies of polymers
- 82D75** Nuclear reactor theory; neutron transport
- 82D77** Quantum waveguides, quantum wires [See also [78A50](#)]
- 82D80** Statistical mechanical studies of nanostructures and nanoparticles
- 82D99** None of the above, but in this section

82Mxx Basic methods in statistical mechanics [See also [65-XX](#)]

- 82M10** Finite element, Galerkin and related methods applied to problems in statistical mechanics
- 82M12** Finite volume methods applied to problems in statistical mechanics
- 82M15** Boundary element methods applied to problems in statistical mechanics
- 82M20** Finite difference methods applied to problems in statistical mechanics
- 82M22** Spectral, collocation and related (meshless) methods applied to problems in statistical mechanics
- 82M25** Other numerical methods applied to problems in statistical mechanics
- 82M30** Variational methods applied to problems in statistical mechanics
- 82M31** Monte Carlo methods applied to problems in statistical mechanics [See also [65C05](#)]
- 82M36** Computational density functional analysis in statistical mechanics
- 82M37** Computational molecular dynamics in statistical mechanics
- 82M60** Stochastic analysis in statistical mechanics [See also [65C35](#)]
- 82M99** None of the above, but in this section

83-XX Relativity and gravitational theory

- 83-00** General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to relativity and gravitational theory
- 83-01** Introductory exposition (textbooks, tutorial papers, etc.) pertaining to relativity and gravitational theory
- 83-02** Research exposition (monographs, survey articles) pertaining to relativity and gravitational theory
- 83-03** History of relativity and gravitational theory [Consider also classification numbers pertaining to Section [01](#)]
- 83-04** Software, source code, etc. for problems pertaining to relativity and gravitational theory
- 83-05** Experimental work for problems pertaining to relativity and gravitational theory
- 83-06** Proceedings, conferences, collections, etc. pertaining to relativity and gravitational theory
- 83-08** Computational methods for problems pertaining to relativity and gravitational theory
- 83-10** Mathematical modeling or simulation for problems pertaining to relativity and gravitational theory
- 83-11** Research data for problems pertaining to relativity and gravitational theory

83Axx Special relativity

83A05 Special relativity

83A99 None of the above, but in this section

83Bxx Observational and experimental questions in relativity and gravitational theory

83B05 Observational and experimental questions in relativity and gravitational theory

83B99 None of the above, but in this section

83Cxx General relativity

83C05 Einstein's equations (general structure, canonical formalism, Cauchy problems)

83C10 Equations of motion in general relativity and gravitational theory

83C15 Exact solutions to problems in general relativity and gravitational theory

83C20 Classes of solutions; algebraically special solutions, metrics with symmetries for problems in general relativity and gravitational theory

83C22 Einstein-Maxwell equations

83C25 Approximation procedures, weak fields in general relativity and gravitational theory

83C27 Lattice gravity, Regge calculus and other discrete methods in general relativity and gravitational theory

83C30 Asymptotic procedures (radiation, news functions, \mathcal{H} -spaces, etc.) in general relativity and gravitational theory

83C35 Gravitational waves

83C40 Gravitational energy and conservation laws; groups of motions

83C45 Quantization of the gravitational field

83C47 Methods of quantum field theory in general relativity and gravitational theory [See also [81T20](#)]

83C50 Electromagnetic fields in general relativity and gravitational theory

83C55 Macroscopic interaction of the gravitational field with matter (hydrodynamics, etc.)

83C56 Dark matter and dark energy

83C57 Black holes

83C60 Spinor and twistor methods in general relativity and gravitational theory; Newman-Penrose formalism

83C65 Methods of noncommutative geometry in general relativity [See also [58B34](#)]

83C75 Space-time singularities, cosmic censorship, etc.

83C80 Analogues of general relativity in lower dimensions

83C99 None of the above, but in this section

83Dxx Relativistic gravitational theories other than Einstein's, including asymmetric field theories

83D05 Relativistic gravitational theories other than Einstein's, including asymmetric field theories

83D99 None of the above, but in this section

83Exx Unified, higher-dimensional and super field theories

83E05 Geometrodynamics and the holographic principle [See also [81T35](#)]

83E15 Kaluza-Klein and other higher-dimensional theories

83E30 String and superstring theories in gravitational theory [See also [81T30](#)]

83E50 Supergravity

83E99 None of the above, but in this section

83Fxx Cosmology

83F05 Cosmology

83F99 None of the above, but in this section

85-XX Astronomy and astrophysics {For celestial mechanics, see [70F15](#)}

85-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to astronomy and astrophysics

85-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to astronomy and astrophysics

85-02 Research exposition (monographs, survey articles) pertaining to astronomy and astrophysics

85-03 History of astronomy and astrophysics [Consider also classification numbers pertaining to Section [01](#)]

85-04 Software, source code, etc. for problems pertaining to astronomy and astrophysics

85-05 Experimental work for problems pertaining to astronomy and astrophysics

85-06 Proceedings, conferences, collections, etc. pertaining to astronomy and astrophysics

85-08 Computational methods for problems pertaining to astronomy and astrophysics

85-10 Mathematical modeling or simulation for problems pertaining to astronomy and astrophysics

85-11 Research data for problems pertaining to astronomy and astrophysics

85Axx Astronomy and astrophysics {For celestial mechanics, see [70F15](#)}

85A04 General questions in astronomy and astrophysics

85A05 Galactic and stellar dynamics

85A15 Galactic and stellar structure

85A20 Planetary atmospheres

85A25 Radiative transfer in astronomy and astrophysics

85A30 Hydrodynamic and hydromagnetic problems in astronomy and astrophysics [See also [76Y05](#)]

85A35 Statistical astronomy

85A40 Cosmology {For relativistic cosmology, see [83F05](#)}

85A99 None of the above, but in this section

86-XX Geophysics [See also [76U05](#), [76V05](#)]

86-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to geophysics

86-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to geophysics

86-02 Research exposition (monographs, survey articles) pertaining to geophysics

86-03 History of geophysics [Consider also classification numbers pertaining to Section [01](#)]

86-04 Software, source code, etc. for problems pertaining to geophysics

86-05 Experimental work for problems pertaining to geophysics

86-06 Proceedings, conferences, collections, etc. pertaining to geophysics

86-08 Computational methods for problems pertaining to geophysics

86-10 Mathematical modeling or simulation for problems pertaining to geophysics

86-11 Research data for problems pertaining to geophysics

86Axx Geophysics [See also [76U05](#), [76V05](#)]

86A04 General questions in geophysics

86A05 Hydrology, hydrography, oceanography [See also [76Bxx](#), [76E20](#), [76Q05](#), [76Rxx](#), [76U05](#)]

86A08 Climate science and climate modeling

86A10 Meteorology and atmospheric physics [See also [76Bxx](#), [76E20](#), [76N15](#), [76Q05](#), [76Rxx](#), [76U05](#)]

86A15 Seismology (including tsunami modeling), earthquakes

86A20 Potentials, prospecting

86A22 Inverse problems in geophysics [See also [35R30](#)]

86A25 Geo-electricity and geomagnetism [See also [76W05](#), [78A25](#)]

86A30 Geodesy, mapping problems

86A32 Geostatistics

86A40 Glaciology

86A60 Geological problems

86A70 Vulcanology; magma and lava flow

86A99 None of the above, but in this section

90-XX Operations research, mathematical programming

- 90-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to operations research and mathematical programming
- 90-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to operations research and mathematical programming
- 90-02 Research exposition (monographs, survey articles) pertaining to operations research and mathematical programming
- 90-03 History of operations research and mathematical programming [Consider also classification numbers pertaining to Section 01]
- 90-04 Software, source code, etc. for problems pertaining to operations research and mathematical programming
- 90-05 Experimental work for problems pertaining to operations research and mathematical programming
- 90-06 Proceedings, conferences, collections, etc. pertaining to operations research and mathematical programming
- 90-08 Computational methods for problems pertaining to operations research and mathematical programming
- 90-10 Mathematical modeling or simulation for problems pertaining to operations research and mathematical programming
- 90-11 Research data for problems pertaining to operations research and mathematical programming

90Bxx Operations research and management science

- 90B05 Inventory, storage, reservoirs
- 90B06 Transportation, logistics and supply chain management
- 90B10 Deterministic network models in operations research {For network control, see 93B70}
- 90B15 Stochastic network models in operations research {For network control, see 93B70}
- 90B18 Communication networks in operations research [See also 68M10, 68M12, 68M18, 94A05] {For networks as computational models, see 68Q06}
- 90B20 Traffic problems in operations research
- 90B22 Queues and service in operations research [See also 60K25, 68M20]
- 90B25 Reliability, availability, maintenance, inspection in operations research [See also 60K10, 62N05]
- 90B30 Production models
- 90B35 Deterministic scheduling theory in operations research [See also 68M20]
- 90B36 Stochastic scheduling theory in operations research [See also 68M20]
- 90B40 Search theory
- 90B50 Management decision making, including multiple objectives [See also 90C29, 90C31, 91A35, 91B06]
- 90B60 Marketing, advertising [See also 91B60]
- 90B70 Theory of organizations, manpower planning in operations research [See also 91D35]
- 90B80 Discrete location and assignment [See also 90C10]
- 90B85 Continuous location
- 90B90 Case-oriented studies in operations research
- 90B99 None of the above, but in this section

- 90Cxx Mathematical programming** [See also [49Mxx](#), [65Kxx](#)]
- 90C05** Linear programming
 - 90C06** Large-scale problems in mathematical programming
 - 90C08** Special problems of linear programming (transportation, multi-index, data envelopment analysis, etc.)
 - 90C09** Boolean programming
 - 90C10** Integer programming
 - 90C11** Mixed integer programming
 - 90C15** Stochastic programming
 - 90C17** Robustness in mathematical programming
 - 90C20** Quadratic programming
 - 90C22** Semidefinite programming
 - 90C23** Polynomial optimization
 - 90C24** Tropical optimization (e.g., max-plus optimization)
 - 90C25** Convex programming
 - 90C26** Nonconvex programming, global optimization
 - 90C27** Combinatorial optimization
 - 90C29** Multi-objective and goal programming
 - 90C30** Nonlinear programming
 - 90C31** Sensitivity, stability, parametric optimization
 - 90C32** Fractional programming
 - 90C33** Complementarity and equilibrium problems and variational inequalities (finite dimensions) (aspects of mathematical programming)
 - 90C34** Semi-infinite programming
 - 90C35** Programming involving graphs or networks [See also [90C27](#)]
 - 90C39** Dynamic programming [See also [49L20](#)]
 - 90C40** Markov and semi-Markov decision processes
 - 90C46** Optimality conditions and duality in mathematical programming [See also [49N15](#)]
 - 90C47** Minimax problems in mathematical programming [See also [49K35](#)]
 - 90C48** Programming in abstract spaces
 - 90C49** Extreme-point and pivoting methods
 - 90C51** Interior-point methods
 - 90C52** Methods of reduced gradient type
 - 90C53** Methods of quasi-Newton type
 - 90C55** Methods of successive quadratic programming type

- 90C56 Derivative-free methods and methods using generalized derivatives [See also [49J52](#)]
- 90C57 Polyhedral combinatorics, branch-and-bound, branch-and-cut
- 90C59 Approximation methods and heuristics in mathematical programming
- 90C60 Abstract computational complexity for mathematical programming problems [See also [68Q25](#)]
- 90C70 Fuzzy and other nonstochastic uncertainty mathematical programming
- 90C90 Applications of mathematical programming
- 90C99 None of the above, but in this section

91-XX Game theory, economics, finance, and other social and behavioral sciences

- 91-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to game theory, economics, and finance
- 91-01 exposition (textbooks, tutorial papers, etc.) pertaining to game theory, economics, and finance
- 91-02 Research exposition (monographs, survey articles) pertaining to game theory, economics, and finance
- 91-03 History of game theory, economics, and finance [Consider also classification numbers pertaining to Section [01](#)]
- 91-04 Software, source code, etc. for problems pertaining to game theory, economics, and finance
- 91-05 Experimental work for problems pertaining to game theory, economics, and finance
- 91-06 Proceedings, conferences, collections, etc. pertaining to game theory, economics, and finance
- 91-08 Computational methods for problems pertaining to game theory, economics, and finance
- 91-10 Mathematical modeling or simulation for problems pertaining to game theory, economics, and finance
- 91-11 Research data for problems pertaining to game theory, economics, and finance

91Axx Game theory

- 91A05 2-person games
- 91A06 n -person games, $n > 2$
- 91A07 Games with infinitely many players
- 91A10 Noncooperative games
- 91A11 Equilibrium refinements
- 91A12 Cooperative games
- 91A14 Potential and congestion games
- 91A15 Stochastic games, stochastic differential games
- 91A16 Mean field games (aspects of game theory) [See also [35Q89](#), [49N80](#)]
- 91A18 Games in extensive form
- 91A20 Multistage and repeated games

- 91A22 Evolutionary games
- 91A23 Differential games (aspects of game theory) [See also [49N70](#)]
- 91A24 Positional games (pursuit and evasion, etc.) [See also [49N75](#)]
- 91A25 Dynamic games
- 91A26 Rationality and learning in game theory
- 91A27 Games with incomplete information, Bayesian games
- 91A28 Signaling and communication in game theory
- 91A30 Utility theory for games [See also [91B16](#)]
- 91A35 Decision theory for games [See also [62Cxx](#), [90B50](#), [91B06](#)]
- 91A40 Other game-theoretic models
- 91A43 Games involving graphs {For games on graphs, see [05C57](#)}
- 91A44 Games involving topology, set theory, or logic
- 91A46 Combinatorial games
- 91A50 Discrete-time games
- 91A55 Games of timing
- 91A60 Probabilistic games; gambling [See also [60G40](#)]
- 91A65 Hierarchical games (including Stackelberg games)
- 91A68 Algorithmic game theory and complexity [See also [68Qxx](#), [68Wxx](#)]
- 91A70 Spaces of games
- 91A80 Applications of game theory
- 91A81 Quantum games
- 91A86 Game theory and fuzziness
- 91A90 Experimental studies
- 91A99 None of the above, but in this section

- 91Bxx Mathematical economics {For econometrics, see [62P20](#)}**
- 91B02 Fundamental topics (basic mathematics, methodology; applicable to economics in general)
- 91B03 Mechanism design theory
- 91B05 Risk models (general) {For actuarial and financial risk, see [91Gxx](#)}
- 91B06 Decision theory [See also [62Cxx](#), [90B50](#), [91A35](#)]
- 91B08 Individual preferences
- 91B10 Group preferences
- 91B12 Voting theory
- 91B14 Social choice

91B15 Welfare economics

91B16 Utility theory [See also [91A30](#)]

91B18 Public goods

91B24 Microeconomic theory (price theory and economic markets)

91B26 Auctions, bargaining, bidding and selling, and other market models

91B32 Resource and cost allocation (including fair division, apportionment, etc.)

91B38 Production theory, theory of the firm

91B39 Labor markets

91B41 Contract theory (moral hazard, adverse selection)

91B42 Consumer behavior, demand theory

91B43 Principal-agent models

91B44 Economics of information

91B50 General equilibrium theory

91B51 Dynamic stochastic general equilibrium theory

91B52 Special types of economic equilibria

91B54 Special types of economic markets (including Cournot, Bertrand)

91B55 Economic dynamics

91B60 Trade models

91B62 Economic growth models

91B64 Macroeconomic theory (monetary models, models of taxation)

91B66 Multisectoral models in economics

91B68 Matching models

91B69 Heterogeneous agent models

91B70 Stochastic models in economics

91B72 Spatial models in economics [See also [91D25](#)]

91B74 Economic models of real-world systems (e.g., electricity markets, etc.)

91B76 Environmental economics (natural resource models, harvesting, pollution, etc.)

91B80 Applications of statistical and quantum mechanics to economics (econophysics)

91B82 Statistical methods; economic indices and measures [See also [62P20](#)]

91B84 Economic time series analysis {For statistical theory of time series, see [62M10](#)}

91B86 Mathematical economics and fuzziness

91B99 None of the above, but in this section

- 91Cxx Social and behavioral sciences: general topics {For statistics, see [62P25](#)}**
- 91C05 Measurement theory in the social and behavioral sciences
 - 91C15 One- and multidimensional scaling in the social and behavioral sciences
 - 91C20 Clustering in the social and behavioral sciences [See also [62H30](#)]
 - 91C99 None of the above, but in this section
- 91Dxx Mathematical sociology (including anthropology)**
- 91D10 Models of societies, social and urban evolution
 - 91D15 Social learning
 - 91D20 Mathematical geography and demography
 - 91D25 Spatial models in sociology [See also [91B72](#)]
 - 91D30 Social networks; opinion dynamics
 - 91D35 Manpower systems in sociology [See also [90B70](#), [91B39](#)]
 - 91D99 None of the above, but in this section
- 91Exx Mathematical psychology {For psychometrics, see [62P15](#)}**
- 91E10 Cognitive psychology
 - 91E30 Psychophysics and psychophysiology; perception
 - 91E40 Memory and learning in psychology [See also [68T05](#)]
 - 91E45 Measurement and performance in psychology
 - 91E99 None of the above, but in this section
- 91Fxx Other social and behavioral sciences (mathematical treatment)**
- 91F10 History, political science
 - 91F20 Linguistics [See also [03B65](#), [68T50](#)]
 - 91F99 None of the above, but in this section
- 91Gxx Actuarial science and mathematical finance {For statistics, see [62P05](#)}**
- 91G05 Actuarial mathematics
 - 91G10 Portfolio theory
 - 91G15 Financial markets
 - 91G20 Derivative securities (option pricing, hedging, etc.)
 - 91G30 Interest rates, asset pricing, etc. (stochastic models)
 - 91G40 Credit risk
 - 91G45 Financial networks (including contagion, systemic risk, regulation)
 - 91G50 Corporate finance (dividends, real options, etc.)

- 91G60 Numerical methods (including Monte Carlo methods)
- 91G70 Statistical methods; risk measures [See also [62P05](#), [62P20](#)]
- 91G80 Financial applications of other theories [See also [35Q91](#), [37N40](#), [49N90](#), [60J70](#), [60K10](#), [60H30](#), [93E20](#)]
- 91G99 None of the above, but in this section

92-XX Biology and other natural sciences

- 92-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to biology
- 92-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to biology
- 92-02 Research exposition (monographs, survey articles) pertaining to biology
- 92-03 History of biology [Consider also classification numbers pertaining to [Section 01](#)]
- 92-04 Software, source code, etc. for problems pertaining to biology
- 92-05 Experimental work for problems pertaining to biology
- 92-06 Proceedings, conferences, collections, etc. pertaining to biology
- 92-08 Computational methods for problems pertaining to biology
- 92-10 Mathematical modeling or simulation for problems pertaining to biology
- 92-11 Research data for problems pertaining to biology

92Bxx Mathematical biology in general

- 92B05 General biology and biomathematics
- 92B10 Taxonomy, cladistics, statistics in mathematical biology
- 92B15 General biostatistics [See also [62P10](#)]
- 92B20 Neural networks for/in biological studies, artificial life and related topics [See also [68T05](#), [82C32](#), [94Cxx](#)]
- 92B25 Biological rhythms and synchronization
- 92B99 None of the above, but in this section

92Cxx Physiological, cellular and medical topics

- 92C05 Biophysics
- 92C10 Biomechanics [See also [74L15](#)]
- 92C15 Developmental biology, pattern formation
- 92C17 Cell movement (chemotaxis, etc.)
- 92C20 Neural biology
- 92C30 Physiology (general)
- 92C32 Pathology, pathophysiology
- 92C35 Physiological flow [See also [76Z05](#)]
- 92C37 Cell biology

- 92C40 Biochemistry, molecular biology
- 92C42 Systems biology, networks
- 92C45 Kinetics in biochemical problems (pharmacokinetics, enzyme kinetics, etc.) [See also [80A30](#)]
- 92C47 Biosensors (not for medical applications)
- 92C50 Medical applications (general)
- 92C55 Biomedical imaging and signal processing [See also [44A12](#), [65R10](#), [94A08](#), [94A12](#)]
- 92C60 Medical epidemiology {For theoretical aspects, see [92D30](#)}
- 92C70 Microbiology
- 92C75 Biotechnology
- 92C80 Plant biology
- 92C99 None of the above, but in this section

92Dxx Genetics and population dynamics

- 92D10 Genetics and epigenetics {For genetic algebras, see [17D92](#)}
- 92D15 Problems related to evolution
- 92D20 Protein sequences, DNA sequences
- 92D25 Population dynamics (general)
- 92D30 Epidemiology {For medical applications, see [92C60](#)}
- 92D40 Ecology
- 92D45 Pest management
- 92D50 Animal behavior
- 92D99 None of the above, but in this section

92Exx Chemistry {For biochemistry, see [92C40](#)}

- 92E10 Molecular structure (graph-theoretic methods, methods of differential topology, etc.)
- 92E20 Classical flows, reactions, etc. in chemistry [See also [80A30](#), [80A32](#)]
- 92E99 None of the above, but in this section

92Fxx Other natural sciences (mathematical treatment)

- 92F05 Other natural sciences (mathematical treatment)
- 92F99 None of the above, but in this section

93-XX Systems theory; control {For optimal control, see [49-XX](#)}

93-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to systems and control theory

93-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to systems and control theory

93-02 Research exposition (monographs, survey articles) pertaining to systems and control theory

93-03 History of systems and control theory [Consider also classification numbers pertaining to Section [01](#)]

93-04 Software, source code, etc. for problems pertaining to systems and control theory

93-05 Experimental work for problems pertaining to systems and control theory

93-06 Proceedings, conferences, collections, etc. pertaining to systems and control theory

93-08 Computational methods for problems pertaining to systems and control theory

93-10 Mathematical modeling or simulation for problems pertaining to systems and control theory

93-11 Research data for problems pertaining to systems and control theory

93Axx General systems theory

93A05 Axiomatic systems theory

93A10 General systems

93A13 Hierarchical systems

93A14 Decentralized systems

93A15 Large-scale systems

93A16 Multi-agent systems

93A99 None of the above, but in this section

93Bxx Controllability, observability, and system structure

93B03 Attainable sets, reachability

93B05 Controllability

93B07 Observability

93B10 Canonical structure

93B11 System structure simplification

93B12 Variable structure systems

93B15 Realizations from input-output data

93B17 Transformations

93B18 Linearizations

93B20 Minimal systems representations

93B24 Topological methods

93B25 Algebraic methods

- 93B27** Geometric methods
- 93B28** Operator-theoretic methods [See also [47A48](#), [47A57](#), [47B35](#), [47N70](#)]
- 93B30** System identification
- 93B35** Sensitivity (robustness)
- 93B36** H^∞ -control
- 93B45** Model predictive control
- 93B47** Iterative learning control
- 93B50** Synthesis problems
- 93B51** Design techniques (robust design, computer-aided design, etc.)
- 93B52** Feedback control
- 93B53** Observers
- 93B55** Pole and zero placement problems
- 93B60** Eigenvalue problems
- 93B70** Networked control
- 93B99** None of the above, but in this section

93Cxx Model systems in control theory

- 93C05** Linear systems in control theory
- 93C10** Nonlinear systems in control theory
- 93C15** Control/observation systems governed by ordinary differential equations [See also [34H05](#)]
- 93C20** Control/observation systems governed by partial differential equations
- 93C23** Control/observation systems governed by functional-differential equations [See also [34K35](#)]
- 93C25** Control/observation systems in abstract spaces
- 93C27** Impulsive control/observation systems
- 93C28** Positive control/observation systems
- 93C29** Boolean control/observation systems
- 93C30** Control/observation systems governed by functional relations other than differential equations (such as hybrid and switching systems)
- 93C35** Multivariable systems, multidimensional control systems
- 93C40** Adaptive control/observation systems
- 93C41** Control/observation systems with incomplete information
- 93C42** Fuzzy control/observation systems
- 93C50** Delay control/observation systems
- 93C55** Discrete-time control/observation systems

- 93C57 Sampled-data control/observation systems
- 93C62 Digital control/observation systems
- 93C65 Discrete event control/observation systems
- 93C70 Time-scale analysis and singular perturbations in control/observation systems
- 93C73 Perturbations in control/observation systems
- 93C80 Frequency-response methods in control theory
- 93C83 Control/observation systems involving computers (process control, etc.)
- 93C85 Automated systems (robots, etc.) in control theory [See also [68T40](#), [70B15](#), [70Q05](#)]
- 93C95 Application models in control theory
- 93C99 None of the above, but in this section

93Dxx Stability of control systems

- 93D05 Lyapunov and other classical stabilities (Lagrange, Poisson, L^p , l^p , etc.) in control theory
- 93D09 Robust stability
- 93D10 Popov-type stability of feedback systems
- 93D15 Stabilization of systems by feedback
- 93D20 Asymptotic stability in control theory
- 93D21 Adaptive or robust stabilization
- 93D22 Exponential stability
- 93D25 Input-output approaches in control theory
- 93D30 Lyapunov and storage functions
- 93D40 Finite-time stability
- 93D50 Consensus
- 93D99 None of the above, but in this section

93Exx Stochastic systems and control

- 93E03 Stochastic systems in control theory (general)
- 93E10 Estimation and detection in stochastic control theory [See also [60G35](#)]
- 93E11 Filtering in stochastic control theory [See also [60G35](#)]
- 93E12 Identification in stochastic control theory
- 93E14 Data smoothing in stochastic control theory
- 93E15 Stochastic stability in control theory
- 93E20 Optimal stochastic control [See also [49J55](#), [49K45](#)]
- 93E24 Least squares and related methods for stochastic control systems
- 93E35 Stochastic learning and adaptive control
- 93E99 None of the above, but in this section

94-XX Information and communication theory, circuits

- 94-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to information and communication theory
- 94-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to information and communication theory
- 94-02 Research exposition (monographs, survey articles) pertaining to information and communication theory
- 94-03 History of information and communication theory [Consider also classification numbers pertaining to Section 01]
- 94-04 Software, source code, etc. for problems pertaining to information and communication theory
- 94-05 Experimental work for problems pertaining to information and communication theory
- 94-06 Proceedings, conferences, collections, etc. pertaining to information and communication theory
- 94-08 Computational methods for problems pertaining to information and communication theory
- 94-10 Mathematical modeling or simulation for problems pertaining to information and communication theory
- 94-11 Research data for problems pertaining to information and communication theory

94Axx Communication, information

- 94A05 Communication theory [See also 60G35, 90B18]
- 94A08 Image processing (compression, reconstruction, etc.) in information and communication theory [See also 68U10]
- 94A11 Application of orthogonal and other special functions
- 94A12 Signal theory (characterization, reconstruction, filtering, etc.)
- 94A13 Detection theory in information and communication theory
- 94A14 Modulation and demodulation in information and communication theory
- 94A15 Information theory (general) [See also 62B10, 81P45]
- 94A16 Informational aspects of data analysis and big data [See also 62R07, 68T09] {For homological aspects, see 55N31}
- 94A17 Measures of information, entropy
- 94A20 Sampling theory in information and communication theory
- 94A24 Coding theorems (Shannon theory)
- 94A29 Source coding [See also 68P30]
- 94A34 Rate-distortion theory in information and communication theory
- 94A40 Channel models (including quantum) in information and communication theory [See also 81P47]
- 94A45 Prefix, length-variable, comma-free codes [See also 20M35, 68Q45]
- 94A50 Theory of questionnaires
- 94A55 Shift register sequences and sequences over finite alphabets in information and communication theory
- 94A60 Cryptography [See also 11T71, 14G50, 68P25, 81P94]
- 94A62 Authentication, digital signatures and secret sharing [See also 81P94]
- 94A99 None of the above, but in this section

94Bxx Theory of error-correcting codes and error-detecting codes

94B05 Linear codes, general

94B10 Convolutional codes

94B12 Combined modulation schemes (including trellis codes) in coding theory

94B15 Cyclic codes

94B20 Burst-correcting codes

94B25 Combinatorial codes

94B27 Geometric methods (including applications of algebraic geometry) applied to coding theory [See also [11T71](#), [14G50](#)]

94B30 Majority codes

94B35 Decoding

94B40 Arithmetic codes [See also [11T71](#), [14G50](#)]

94B50 Synchronization error-correcting codes

94B60 Other types of codes

94B65 Bounds on codes

94B70 Error probability in coding theory

94B75 Applications of the theory of convex sets and geometry of numbers (covering radius, etc.) to coding theory [See also [11H31](#), [11H71](#)]

94B99 None of the above, but in this section

94Cxx Circuits, networks [See also [68Q06](#)]

94C05 Analytic circuit theory

94C11 Switching theory, applications of Boolean algebras to circuits and networks

94C12 Fault detection; testing in circuits and networks

94C15 Applications of graph theory to circuits and networks [See also [05Cxx](#), [68R10](#)]

94C30 Applications of design theory to circuits and networks [See also [05Bxx](#)]

94C60 Circuits in qualitative investigation and simulation of models

94C99 None of the above, but in this section

94Dxx Miscellaneous topics in information and communication theory

94D05 Fuzzy sets and logic (in connection with information, communication, or circuits theory) [See also [03B52](#), [03E72](#), [28E10](#)]

94D10 Boolean functions [See also [06E30](#)] {For connections with circuits and networks, see [94C11](#)}

94D99 None of the above, but in this section

97-XX Mathematics education

97-00 General reference works (handbooks, dictionaries, bibliographies, etc.) pertaining to mathematics education

97-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to mathematics education

97-02 Research exposition (monographs, survey articles) pertaining to mathematics education

97-03 History of mathematics education [Consider also classification numbers pertaining to Section [01](#)]

97-06 Proceedings, conferences, collections, etc. pertaining to mathematics education

97-11 Research data for problems pertaining to mathematics education

97Axx History and society (aspects of mathematics education)

97A30 History in mathematics education {For mathematics history, see [01-XX](#); for biographies, see [01A70](#); for history of mathematics education, see [97-03](#)}

97A40 Mathematics education and society {For sociology (and profession) of mathematics, see [01A80](#)}

97A99 None of the above, but in this section

97Bxx Educational policy and systems

97B10 Mathematics educational research and planning

97B20 Educational policy for general education

97B30 Educational policy for vocational education

97B40 Educational policy for higher education

97B50 Mathematics teacher education

97B60 Educational policy for adult and further education

97B70 Syllabuses, educational standards

97B99 None of the above, but in this section

97Cxx Psychology of mathematics education, research in mathematics education

97C10 Comprehensive works on psychology of mathematics education

97C20 Affective behavior and mathematics education

97C30 Cognitive processes, learning theories (aspects of mathematics education)

97C40 Intelligence and aptitudes (aspects of mathematics education)

97C50 Language and verbal communities (aspects of mathematics education)

97C60 Sociological aspects of learning (aspects of mathematics education)

97C70 Teaching-learning processes in mathematics education

97C99 None of the above, but in this section

97Dxx Education and instruction in mathematics

97D10 Comprehensive works and comparative studies on education and instruction in mathematics

97D20 Philosophical and theoretical contributions (maths didactics)

97D30 Objectives and goals of mathematics teaching

97D40 Mathematics teaching methods and classroom techniques

97D50 Teaching mathematical problem solving and heuristic strategies

97D60 Student assessment, achievement control and rating (aspects of mathematics education)

97D70 Learning difficulties and student errors (aspects of mathematics education)

97D80 Mathematics teaching units and draft lessons

97D99 None of the above, but in this section

97Exx Education of foundations of mathematics

97E10 Comprehensive works on education of foundations of mathematics

97E20 Philosophy and mathematics (educational aspects)

97E30 Logic (educational aspects)

97E40 Language of mathematics (educational aspects)

97E50 Reasoning and proving in the mathematics classroom

97E60 Sets, relations, set theory (educational aspects)

97E99 None of the above, but in this section

97Fxx Education of arithmetic and number theory

97F10 Comprehensive works on education of arithmetic and number theory

97F20 Pre-numerical stage, concept of numbers

97F30 Natural numbers (educational aspects)

97F40 Integers, rational numbers (educational aspects)

97F50 Real numbers, complex numbers (educational aspects)

97F60 Number theory (educational aspects)

97F70 Measures and units (educational aspects)

97F80 Ratio and proportion, percentages (educational aspects)

97F90 Real life mathematics, practical arithmetic (educational aspects)

97F99 None of the above, but in this section

97Gxx Geometry education

- 97G10** Comprehensive works on geometry education
- 97G20** Informal geometry (educational aspects)
- 97G30** Area and volume (educational aspects)
- 97G40** Plane and solid geometry (educational aspects)
- 97G50** Transformation geometry (educational aspects)
- 97G60** Plane and spherical trigonometry (educational aspects)
- 97G70** Analytic geometry, vector algebra (educational aspects)
- 97G80** Descriptive geometry (educational aspects)
- 97G99** None of the above, but in this section

97Hxx Algebra education

- 97H10** Comprehensive works on algebra education
- 97H20** Elementary algebra (educational aspects)
- 97H30** Equations and inequalities (educational aspects)
- 97H40** Groups, rings, fields (educational aspects)
- 97H50** Ordered algebraic structures (educational aspects)
- 97H60** Linear algebra (educational aspects)
- 97H99** None of the above, but in this section

97Ixx Analysis education

- 97I10** Comprehensive works on analysis education
- 97I20** Mappings and functions (educational aspects)
- 97I30** Sequences and series (educational aspects)
- 97I40** Differential calculus (educational aspects)
- 97I50** Integral calculus (educational aspects)
- 97I60** Functions of several variables (educational aspects)
- 97I70** Functional equations (educational aspects)
- 97I80** Complex analysis (educational aspects)
- 97I99** None of the above, but in this section

97Kxx Education of combinatorics, graph theory, probability theory, and statistics

97K10 Comprehensive works on combinatorics, graph theory, and probability (educational aspects)

97K20 Combinatorics (educational aspects)

97K30 Graph theory (educational aspects)

97K40 Descriptive statistics (educational aspects)

97K50 Probability theory (educational aspects)

97K60 Distributions and stochastic processes (educational aspects)

97K70 Foundations and methodology of statistics (educational aspects)

97K80 Applied statistics (educational aspects)

97K99 None of the above, but in this section

97Mxx Education of mathematical modeling and applications of mathematics

97M10 Modeling and interdisciplinarity (aspects of mathematics education)

97M20 Mathematics in vocational training and career education

97M30 Financial and insurance mathematics (aspects of mathematics education)

97M40 Operations research, economics (aspects of mathematics education)

97M50 Physics, astronomy, technology, engineering (aspects of mathematics education)

97M60 Biology, chemistry, medicine (aspects of mathematics education)

97M70 Behavioral and social sciences (aspects of mathematics education)

97M80 Arts, music, language, architecture (aspects of mathematics education)

97M99 None of the above, but in this section

97Nxx Education of numerical mathematics

97N10 Comprehensive works education of numerical mathematics

97N20 Rounding, estimation, theory of errors (educational aspects)

97N30 Numerical algebra (educational aspects)

97N40 Numerical analysis (educational aspects)

97N50 Interpolation and approximation (educational aspects)

97N60 Mathematical programming (educational aspects)

97N70 Discrete mathematics (educational aspects)

97N80 Mathematical software, computer programs (educational aspects)

97N99 None of the above, but in this section

97Pxx Computer science (educational aspects)

97P10 Comprehensive works on computer science (educational aspects)

97P20 Theoretical computer science (educational aspects)

97P30 Systems, databases (educational aspects)

97P40 Programming languages (educational aspects)

97P50 Programming techniques (educational aspects)

97P80 Artificial intelligence (educational aspects)

97P99 None of the above, but in this section

97Uxx Educational material and media and educational technology in mathematics education

97U10 Comprehensive works on educational material and media and educational technology in mathematics education

97U20 Textbooks, textbook research (aspects of mathematics education)

97U30 Teachers' manuals and planning aids (aspects of mathematics education)

97U40 Problem books, competitions, examinations (aspects of mathematics education)

97U50 Computer-assisted instruction, e-learning (aspects of mathematics education)

97U60 Manipulative materials (aspects of mathematics education)

97U70 Technological tools, calculators (aspects of mathematics education)

97U80 Audiovisual media (aspects of mathematics education)

97U99 None of the above, but in this section